

For Reference

NOT TO BE TAKEN FROM THIS ROOM

Ex LIBRIS
UNIVERSITATIS
ALBERTAENSIS





Digitized by the Internet Archive
in 2020 with funding from
University of Alberta Libraries

<https://archive.org/details/Schurr1970>

THE UNIVERSITY OF ALBERTA

ACQUISITION AND EXTINCTION OF THE CONDITIONED EYELID
RESPONSE AS A FUNCTION OF SCHEDULE OF REINFORCEMENT
AND UCS INTENSITY IN TWO MASKED CONDITIONING PROCEDURES

by



BRYCE CHARLES SCHURR

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF SCIENCE

DEPARTMENT OF PSYCHOLOGY

EDMONTON, ALBERTA

FALL, 1970

7628
970F
241

UNIVERSITY OF ALBERTA
FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Acquisition and Extinction of the Conditioned Eyelid Response as a Function of Schedule of Reinforcement and UCS Intensity in Two Masked Conditioning Procedures" submitted by Bryce C. Schurr, in partial fulfilment of the requirements for the degree of Master of Science in Psychology.

Date: Sept 26th 1970

ABSTRACT

The effects of the schedule of reinforcement and UCS intensity upon acquisition and extinction of the eyelid CR were examined in the context of two cognitive masking procedures. All Ss received 90 acquisition and 30 extinction trials in which nonreinforcement involved omission of the UCS. Results showed significant acquisition performance decrements associated with schedules of partial reinforcement, and rapid extinction of the CR following continuous reinforcement. Both results contradicted previous experiments varying the schedule of reinforcement. While UCS intensity had the effect of increasing acquisition performance under a replication of previous masking procedures, it failed to affect performance in a modified procedure. An effect of UCS intensity was noted in performance during extinction in one condition of the modified procedure, but failed to influence the rate of extinction in any other condition. Questions of the appropriateness of previous interpretations were raised in light of the present findings. Of specific interest was the possible effect of the inclusion of the UCS on nonreinforced trials of acquisition and during extinction in the context of the cognitive masking procedure.

ACKNOWLEDGEMENTS

I would like to express my appreciation to Dr. W.N. Runquist for his guidance, counsel and advice in the design, data collection and completion of this thesis. There are many others to whom I owe my gratitude as well. Mr. Paul DeGroot and Mr. Pat Wong spent many a longer-than-usual day trying to explain the design, operation and theory behind the construction of the apparatus. I would also like to thank Mr. Dennis Foth for his critical review of the preliminary work and helpful advice in interpreting the pilot data.

The assistance of Mrs. Gail Williams in the preparation of the final copies and Mrs. Marva Blackmore, who helped me correct the drafts, is greatly appreciated. Only they know how it would have been impossible for me to prepare this thesis alone.

I will always be indebted to Dr. Samuel R. Pinneau who first suggested that I give up my errant life to return to graduate school. There have been times in the past two years, however, at which I have doubted the wisdom of his suggestion. Most of all, I would like to acknowledge the varied assistance of my wife Susan. She has remained unflappable in the face of my "free-floating" anxieties and continued to offer her support in the ways only a husband can recognize.

Finally, but by no means the least of, my gratitude goes to the 166 individuals who willingly, for the most part, gave of their time to serve as experimental Ss.

To those I have forgotten, my apologies and sincere appreciation.

Bryce C. Schurr

TABLE OF CONTENTS

	Page
ABSTRACT	
ACKNOWLEDGEMENTS	
LIST OF FIGURES.....	i
LIST OF TABLES.....	ii
INTRODUCTION.....	1
Theories of Extinction.....	2
Inhibition theory.....	2
Expectancy theory.....	5
Discrimination hypothesis.....	11
Experiments in the Cognitive Masking Procedure.....	19
Effects of UCS Intensity.....	31
Experiments involving continuous reinforcement.....	34
Experiments involving partial reinforcement.....	35
Effects of ready signals.....	38
Statement of Problem.....	41
METHOD.....	43
Subjects.....	43
Apparatus.....	43
Design.....	46
Procedure.....	49

Table of Contents (Continued):

	Page
RESULTS.....	52
CRs Acquisition.....	52
CRs Extinction.....	64
Probability Learning.....	75
DISCUSSION.....	82
REFERENCES.....	99
FOOTNOTES.....	108
APPENDICES.....	111

LIST OF FIGURES

	Page
Figure 1: Comparison of the temporal relations of components of the two masking procedures.....	47
Figure 2: Proportion CRs emitted within blocks of 10 acquisition trials.....	53
Figure 3: Proportion CRs emitted over the last 30 acquisition trials.....	62
Figure 4: Proportion CRs emitted in trial blocks of the extinction period.....	65
Figure 5: Shape function indices $[f(n)]$ of extinction curves.....	72
Figure 6: Proportion A_1 responses within blocks of 20 PL trials.....	76

LIST OF TABLES

	Page
Table I: Analysis of variance of transformed proportion CRs in blocks of 10 acquisition trials.....	56
Table II: Linear and quadratic components of acquisition Trials effects.....	57
Table III: Analysis of variance of proportion CRs over 45 reinforced acquisition trials.....	59
Table IV: Analysis of variance of the transformed proportion CRs emitted in last 30 acquisition trials.....	61
Table V: Analysis of variance of transformed proportion CRs over extinction trials...	66
Table VI: Linear and quadratic components of extinction Trial effects.....	69
Table VII: Analysis of variance of $\bar{f}(15)$ and $\bar{f}(30)$ shape function indices for extinction curves.....	74
Table VIII: Analysis of variance of proportion A_1 responses over last 80 PL trials.....	79

INTRODUCTION

When a conditioned stimulus (CS) is presented repeatedly, without its usual reinforcement, the conditioned response (CR) shows progressive decrements termed experimental extinction. Humphreys (1939a) demonstrated that the rate of CR decrement was significantly affected by the schedule of reinforcement¹ during acquisition. Extinction was slower following an acquisition schedule which included presentation of the CS alone (partial reinforcement) than when the acquisition period involved continuous reinforcement. This result, substantiated in a variety of conditioning situations, has become known as Humphreys' paradox (Kimble, 1961) or the partial reinforcement effect (PRE) of extinction.

This thesis is concerned with the applicability of theoretic positions arising from studies where elimination of the PRE has been accomplished by modification of the standard conditioning procedure. Specifically, attention is directed to the proposition that cognitive or higher order factors, responsible for the PRE, may be effectively eliminated by inclusion of a secondary conditioning task. It is argued that previous procedures and evidence have not proved a sufficient test of this proposition and that the results may be as effect-

ively interpreted from alternative positions.

Since CRs show little or no response decrement solely due to the passage of time without training, extinction must be assumed to result from "some active process associated with nonreinforcement [Kimble, 1961, p. 324]". The question of what the process involves has led to a variety of theoretical propositions. The importance of the PRE was that it threatened the inhibition theory of extinction within classical behavior theory.

Theories of Extinction

Inhibition theory. A variety of theories propose the process of response inhibition as the mechanism of experimental extinction. Most notable of these are the propositions of Hull (1943) and Spence (1956) couched in the concepts of classical behavior theory. Briefly, both theories propose a model of response acquisition involving two central variables. The major components are D, a generalized drive factor, and H, a learning factor called habit strength, which combine multiplicatively to produce the excitatory (response) potential E; e.g., $E = D \times H$.

Increments in H and, thus, E result from response-contingent reinforcement following the CS (Hull, 1943). A reaction evoked in an organism, however, also produces

a temporary negative drive state which leads to the cessation of activity. This drive is referred to as reactive inhibition ($\underline{I}_r$). In addition, stimuli associated with the production of $\underline{I}_r$ become themselves conditioned to it through drive reduction resulting from dissipation of $\underline{I}_r$ over time. Both $\underline{I}_r$ and the conditioned inhibition ($\underline{s}\underline{I}_r$) summate to form $\dot{\underline{I}}_r$ (total inhibitory potential) which produces decrements in $\underline{E}$ resulting from a lessening of the effects of increases in $\underline{H}$. Thus, the equation solving $\underline{E}$ may be rewritten as $\underline{E} = (\underline{D} \times \underline{H}) - \dot{\underline{I}}_r$.

Hull's propositions regarding the process of extinction were never as fully formalized as his theory of acquisition. Experimental results, however, led Hull to acknowledge that repeated nonreinforcement led to a progressive weakening of the CR. It is a logical possibility that nonreinforced presentations of the CS weakened $\underline{H}$. However, this contradicts assumptions of the semipermanent and relatively immutable nature of the variable (Walker, 1967). Moreover, unless specifically extinguished by the conditioning of competing responses, CRs rarely exhibit total and permanent extinction (Kimble, 1961). Hull's (1943) assumptions regarding extinction may be summarized in terms of the successive increments of $\dot{\underline{I}}_r$ over the extinction period. Since reinforcement

is absent during extinction, increments in $\underline{H}$ no longer occur yet $\underline{I_r}$ continues to increase as a function of response produced $\underline{I_r}$ reduction.

The elaboration of Hull's theory, provided by Spence (1956), assumed that extinction is the function solely of a failure to provide reinforcement on successive trials. While the concept of $\underline{I_r}$ requires response on the part of $\underline{S}$, Spence introduced a concept of inhibition ($\underline{I_n}$) which required only the disruption of the contingency between the CS and unconditioned stimulus (UCS). Extinction was assumed to develop as the result of a weakening of $\underline{E}$ through repeated nonreinforced presentations of the CS, and did not require the $\underline{S}$'s response in the development of response inhibition.

Both theories predict a negatively accelerated rate of extinction as a function of the number of nonreinforced trials and greater resistance to extinction following continuous rather than partial reinforcement. Spence (1956) proposed that resistance to extinction increased as a linear function of $\underline{H}$. That is, the greater the degree of learning the less steep the slope of extinction curves. For Hull (1943) greater resistance to extinction was predicted as a function of increasing $\underline{E}$. The frequency of reinforcement during acquisition is, however, supposedly related to the degree of learning and, as a result, $\underline{H}$.

All other things being equal, as H increases E should increase proportionally. Evidence of the PRE, in which continuously reinforced Ss show markedly less resistance to extinction than partially reinforced Ss, contradicts the predictions from these theories.

Expectancy theory. Humphreys (1939a) proposed a model of response acquisition and extinction which was based on the general expectancy propositions of Tolman and Brunswik (1939). Response acquisition depends, not upon the frequency of reinforcement, but on the probability that the UCS will follow the CS. Tolman (1959) argued that the organism, instead of acquiring response habits to the CS, learned the sign-significates of the environment which then led to adoption of a particular behavior. One of the primary events assumed to be learned was the probability of reinforcement on any trial; developed as a perceptual expectancy during acquisition. Thus, the theory contends that Ss conditioned under partial reinforcement tend to emit fewer CRs as a function of the expectancy of the presentation of a UCS rather than as the effect of a lower degree of learning.

Tolman proposed that extinction occurred as the result of a counterexpectancy of reinforcement developed as the correlation between the CS and UCS approached zero

over trials (Kimble, 1961). Differential rates of extinction between reinforcement groups was explained by Humphreys (1939a) as a function of the shift in expectation of reinforcement. The rapid extinction of continuously reinforced Ss was due to the ease with which the counterexpectancy of uniform nonreinforcement was established. Experiencing nonreinforcement during acquisition, the gradual decline of partially reinforced Ss was attributed to the greater degree of difficulty associated with development of the counterexpectancy of extinction.

Employing a verbal task, Humphreys (1939b) reported an experiment which confirmed these conjectures. A signal light (SL) and response light (RL) were mounted on a panel. During the course of the "acquisition" period, SL was turned on and Ss predicted whether or not the RL would be turned on next. Half of the Ss received a uniform schedule of SL-RL lightings and the remaining Ss a schedule in which the RL followed the SL on a random half of the trials. Results at the end of "acquisition" showed the usual partial reinforcement decrement, with predictions of the RL-on at a chance level. "Extinction" involved uniform nonreinforcement; i.e., RL never followed the SL. As in the eyelid conditioning experiment (Humphreys, 1939a), a significant "PRE" was noted. That is, Ss receiving the intermittent

reinforcement schedule during "acquisition" showed much greater resistance to "extinction". Continuously reinforced Ss, on the other hand, showed a rapid decrease in their expectancy of the occurrence of the RL and quickly adopted the expectancy of uniform nonreinforcement. The "PRE" was interpreted as the function of the ease with which Ss were able to adopt the counterexpectancy of "extinction". As Humphreys (1939a) reported, "A single nonreinforcement is a much more impressive experience following uniform reinforcement..." than when it follows intermittent reinforcement [p. 157].

A proposition emphasizing this factor has been presented by Mowrer and Jones (1945) as the discrimination hypothesis of extinction. According to this hypothesis, extinction is retarded when it is difficult for the organism to distinguish between the procedures of extinction and acquisition. During acquisition under a schedule of partial reinforcement Ss develop expectancies of the probabilistic nature of the CS-UCS contingency. Removal of the UCS during extinction serves to strengthen, at first, the expectancy of the UCS as a function of successive nonreinforcements during acquisition (Humphreys, 1939b). In addition, the onset of extinction following partial reinforcement is not clearly delineated, so that discriminability between the proced-

ures of acquisition and extinction is diminished (Mowrer and Jones, 1945), and the counterexpectancy of uniform nonreinforcement is developed with more difficulty (Humphreys, 1939b).

Ross (1959) reported a study involving changes in the schedule of reinforcement during acquisition which is formally amenable to interpretation by an expectancy-type theory. Five groups were employed: continuous or partial reinforcement throughout acquisition, continuous reinforcement over either 20 or 100 trials followed by 50% partial reinforcement, and partial reinforcement for 40 trials followed by a shift to continuous reinforcement. Results showed that switching to partial following 100 continuously reinforced trials produced an immediate decrement in responding to the level of the partial reinforcement group. Increasing the schedule of reinforcement from partial to continuous reinforcement after 40 trials resulted in an increase in the frequency of CRs to the level of the continuously reinforced Ss. However, the rate of change was less when the change was from a partial to continuous reinforcement schedule than from a continuous to partial schedule. Reducing the schedule of reinforcement following 20 continuously reinforced trials resulted in little change in performance until the partial reinforcement group reached the same level of

responding. Following equating performance, both groups increased at the same rate.

Ross interpreted the results in terms of the presence of some inhibitory response factor resulting from nonreinforced trials. He concluded that the differential slopes between the change-of-reinforcement conditions were due to the fact that response inhibition was acquired faster than it was dissipated. However, these results may be interpreted equally as well in terms of the acquisition of counterexpectancies.

The rapid response decrement evidenced when partial reinforcement was instituted following 100 trials of continuous reinforcement is similar to the rate of extinction following the same reinforcement schedule. The established expectancy for uniform reinforcement is quickly substituted by the expectancy of intermittent reinforcement. The less rapid change noted when reinforcement shifts from partial to continuous may also be the result of expectancies regarding the sequence of CS-UCS contingencies developed over the preceding 40 trials. Since random reinforcement schedules typically include sequences in which reinforcement occurs on successive trials, the shift from partial to continuous may be less discriminable than the shift from continuous to partial. Likewise, when conditioning involves continuous

reinforcement for only 20 trials, expectancies may not be sufficiently established to allow for the rapid discrimination between reinforcement conditions.

Kimble (1967) has emphasized the role of expectancies from the viewpoint of "response sets" acquired during acquisition. A S's set of attitudes is characterized by his general reaction to the experimental situation. His performance is governed by the information he obtains regarding the CS-UCS contingency, the intensity and the effects of the UCS, and certain motivational considerations regarding his behavior in the face of this information. Kimble and others (Tolman, 1959; Grings, 1965; Prokasy, 1965; Rescorla, 1967) have emphasized the perceptual expectancies developed by S as the result of the conditioning procedure. These are viewed as necessary conditions to response acquisition and serve to govern the behavior adopted by S throughout the experiment.

Most objections to expectancy theory have arisen, not as the result of failures to predict the effects of reinforcement schedules on extinction, but because of the perceptual-cognitive nature of the theory. Expectancy theory tends to look upon the PRE as an effect of cognitive hypotheses established during acquisition or the effects of discrimination between procedures of acquisition and extinction. S-R theories, under stronger

stimulus control of the "American Revolution" (Hebb, 1960), have tended to turn to the more behaviorally obvious explanations expressing the effects of secondary reinforcement, response competition and inhibition. Although strong doubt has been expressed regarding the validity of certain concepts (Rescorla, 1969), S-R theories, in general, have avoided contact with the cognitive aspects of the experimental S. The competence of expectancy theory is seen in its ability to account for the PRE in the face of S-R attempts to explain it away.

Discrimination hypothesis. Spence (1956) concluded that evidence supporting an inhibition theory of extinction within classical conditioning was at best minimal: "I have the feeling that all attempts so far have been too oversimplified in that other factors than some kind of inhibitory process affect [the] response decrement [Spence, 1956, p. 122]." A series of experiments over the following decade attempted to provide evidence for what was to become the major mechanism of the extinction process within this theory.

Within instrumental reward situations Spence (1956) had hypothesized that response decrements resulting from experimental extinction were associated with frustration and response inhibition. However, in the classical condi-

tioning paradigm, frustration-aroused incompatible responses were assumed to play a minor role in the extinction process. Although frustration was excluded as a possible effect of UCS omission, the nature of the effect was uncertain.

Classically conditioned responses in animals sometimes required as many trials to extinguish as they did to accomplish conditioning (Spence, 1966b). On the other hand, humans exhibited marked decrements in the frequency of CRs following as few as one or two extinction trials when acquisition was under continuous reinforcement. A cognitive inhibitory set, present in humans but not in animals, was assumed to establish itself early in extinction and was responsible for the rapid rate of extinction. Evidence supporting this assumption was drawn from two sources: effects of instructional sets, and results from experiments degrading the difference between acquisition and extinction periods.

Studies of the effects of facilitory and inhibitory instructions have generally produced results comparable with those of Norris and Grant (1948). Ss instructed to inhibit responses to the CS show significantly fewer CRs than Ss provided neutral or facilitory instructions. However, the instructional sets assumed to operate during extinction (Spence, 1963, 1966b) were S-induced rather than provided through formal instructions. In essence,

these sets are analogous to the cognitive and motivational factors assumed by Kimble (1967) to influence the conditioning process.

It was argued (Spence, 1963) that changes in the experimental procedure allowed S to discriminate between the conditions of acquisition and extinction. Following continuous reinforcement, as few as one or two non-reinforcements may be necessary for the discrimination. As a result, an inhibitory set not to respond to the CS was quickly adopted. Under a schedule of partial reinforcement, Ss experienced nonreinforcement during acquisition and the shift to uniform nonreinforcement was not as readily discriminable as the shift from continuous reinforcement. Spence, Homzie and Rutledge (1964) concluded that the rate of extinction following partial reinforcement was due to the absence or delayed acquisition of an S-induced inhibitory set not to respond to the CS.

Central to these propositions is the effect of discrimination between the procedures of acquisition and extinction. Several studies have attempted to assess the effects of reduced procedural discriminability on the rates of extinction of classically conditioned responses. One of the critical features of the acquisition phase absent in extinction is presentation of the

UCS.

McAllister (1953) examined the effects of maintaining the UCS throughout extinction by varying the CS-UCS interval. All groups in the study were conditioned under 80% partial reinforcement with 450-msec. interstimulus interval (ISI), and returned the following day for extinction trials. Two groups received 100 extinction trials which included the UCS; the CS-UCS interval for Group A was extended to 2500 msec., while Group B was extinguished with a 35-msec. ISI. Group C was administered 40 extinction trials in the absence of the UCS.

Results showed a significant effect of maintaining the UCS throughout extinction. Extinguished without the UCS, Group C showed a 30% performance decrement over the first 10 trials. On the other hand, Group A required 30 trials to reach the same level. When CRs were measured on CS-alone trials, Group B showed a significantly less steep slope of extinction than the other groups. Reynolds (1958) argued that including the UCS during extinction served to maintain D and reduce the possibility of a shift in the "set to receive the UCS" developed during acquisition. The gradual extinction of Groups A and B (McAllister, 1953) was taken as evidence that presentation of the UCS at these ISIs was insufficient to maintain effective reinforcement.

A later study (Reynolds, 1958) examined the effects of the extended CS-UCS interval on extinction following continuous and partial reinforcement. Reinforcement groups were divided so that extinction involved an extended ISI for half of the Ss and omission of the UCS for the remaining Ss. For the partial reinforcement group, nonreinforcement involved extension of the CS-UCS interval to 2500-msec. Results following acquisition showed partially reinforced Ss emitting significantly fewer CRs, even when equated with the continuous group for the number of reinforced trials. This decrement was interpreted as a function of an inhibitory factor associated with nonreinforcement.

The partially reinforced group extinguished with the extended ISI showed greater resistance to extinction than did either of the continuously reinforced groups. However, when extinction involved omission of the UCS, the partial reinforcement group showed as rapid a response decrement as both of the continuously reinforced groups! Following continuous reinforcement, presence or absence of the UCS had no effect upon rates of extinction.

The degree of similarity between acquisition and extinction procedures was assumed to account for differences between the continuous and extended ISI partial

reinforcement groups. Partially reinforced Ss received 40 trials during acquisition with the extended ISI. Thus, transfer to a uniform extended ISI condition involved less change in procedures than the transfer from continuous reinforcement to either of the extinction procedures. Although McAllister (1953) contended that extension of the ISI maintained D throughout extinction, Reynolds (1958) was unable to provide an explanation for the equivalent performance of the continuously reinforced groups.

Failure to find significant effects of extended ISI on extinction following continuous reinforcement has also been reported by Spence, Rutledge and Talbot (1963). However, other studies (Spence, 1963; Spence, Homzie and Rutledge, 1964, [Experiment I]) have reported that, following continuous reinforcement the use of an extended CS-UCS interval produced less rapid extinction than presenting the CS alone. In previous research the CS duration during acquisition had been 2000 msec. shorter than during extinction. For the latter experiments, a constant 2500 msec. CS duration was maintained throughout acquisition and extinction. Spence, Homzie and Rutledge (1964) concluded that failure to find the effects of ISI extension in previous studies was due to the fact that Ss were able to successfully discriminate between conditions of acqui-

sition and extinction by means of the differential CS durations. Successful discrimination resulted in Ss more readily recognizing the onset of extinction (Spence, 1966b) and produced the adoption of an inhibitory response set not to blink to the CS (Spence, Rutledge and Talbot, 1964). On the other hand, at least one study (Price, Abbot and Vandament, 1965) has reported that, although omission or delay of the UCS produced differing rates of extinction, altering the duration of the CS had no effect.

Questioning Ss following experiments (Spence, 1963; Spence, Homzie and Rutledge, 1964) showed that a vast majority of Ss reported noticing the shift to extinction following continuous reinforcement. Although a variety of sources (Adams, 1957; Postman, 1962; Grings, 1965) have doubted the sufficiency of verbal reports for the demonstration of awareness, Spence (1963) concluded that, failing to "realize" that their eyelids had been conditioned, Ss became aware (i.e., were able to verbalize) of the procedural shift from acquisition to extinction. No data are available regarding the degree of recognition following a schedule of partial reinforcement. However, Spence, Homzie and Rutledge (1964) argued that, when the acquisition schedule involves experience of nonreinforcement, "the shift to 0% rein-

forcement is not as readily discriminable as is the shift from 100% reinforcement to 0% [p. 545]".

To this point, the Mowrer-Jones and Spence discrimination hypotheses of extinction appear highly similar. However, there are two critical differences between the propositions which establish them within their respective theoretical frameworks. Both proposals attribute the PRE to differential degree of discriminability between the procedures of acquisition and extinction. According to the Mowrer-Jones hypothesis, partial reinforcement results in an expectancy that the CS will not always precede the UCS. Thus, the counterexpectancy of uniform nonreinforcement is more difficult to establish during extinction. Spence, on the other hand, has assumed that an intermittent reinforcement schedule during acquisition produced less likelihood of the development of an inhibitory response set during extinction.

The Mowrer-Jones hypothesis assumes that extinction is the function of the new UCS expectancies and tends to look upon these as necessary events for the process of extinction. In contrast, Spence (1963, 1966b) has termed cognitive factors as unknown and unwanted variables, contributing little to the knowledge of the process of extinction. With the effects properly controlled or eliminated, extinction is assumed to proceed

at a rate compatible with the propositions of inhibition within classical behavior theory. To this end, Spence has attempted to further reduce the discriminability between acquisition and extinction through a series of experiments involving the "cognitive masking procedure".

Experiments in the Cognitive Masking Procedure

Briefly, the technique involves the simultaneous scheduling of two conditioning procedures. A Humphreys-type verbal conditioning procedure is run in addition to the normal eyelid conditioning paradigm. Verbal conditioning involves a binary prediction task in which Ss attempt to predict correctly which of two RLs will follow an SL (Estes and Straughan, 1954). The upper panel of Figure 1 (p. 47) presents a schematic of this combined conditioning paradigm. The assumption behind the development of this technique was that it would eliminate cognitive factors which tended to disrupt the normal extinction process.

Spence (1963) first reported use of the masking procedure in a comparison of extinction rates among three different procedures. All groups received 50 continuously reinforced acquisition trials and 30 extinction trials. One group received CS-alone (Group I), another delayed UCS (Group II) extinction trials. The procedure for Group III involved delayed UCS with the

inclusion of the second, probability learning (PL) task. Results showed the acquisition performance of Group III to be nearly 20% below that of either Group I or Group II. Rates of extinction for the three groups differed significantly, with Group I showing the most rapid extinction. Group II, presented a delayed UCS (2500-msec. ISI), demonstrated an extinction rate significantly less steep than Group I but extinguished more rapidly than Group III. The less rapid extinction, in addition to the lack of subjective awareness (as indicated by verbal reports), in Group III was attributed to the addition of the second conditioning procedure and the resulting masking of cognitive variables. Differences between the extinction rates of Groups I and II were attributed to the maintenance of D by the delayed UCS procedure and the constant CS duration discussed above. Spence concluded that although delayed UCS procedures reduced the discriminability between acquisition and extinction procedures, higher order variables remained as potent factors controlling extinction. Addition of the masking procedure, however, controlled to a greater extent the operation of these factors, as far as extinction was concerned.

The first experiment examining the effects of the cognitive masking procedure on varying schedules of rein-

forcement was Goldstein's (1962) doctoral dissertation, reported by Spence (1966b). This experiment involved the effects of continuous and 60% partial reinforcement and, orthogonally, the absence or presence of the UCS during extinction. At the end of acquisition, Ss in the partial reinforcement groups showed a slight (10%) performance decrement compared to continuously reinforced groups. When extinction involved a delayed UCS, partial and continuous groups both showed a gradual rate of extinction; 30% over the 100 extinction trials. Under the CS-alone procedure, both reinforcement groups evidenced rapid extinction approaching their lowest level of performance following the first 10 trials of extinction. Although a PRE was noted in the delayed UCS procedure, the fact that both CS-alone groups extinguished rapidly was more bothersome. Since cognitive factors were assumed to be controlled, a classical behavior theory would assume that the rapid extinction was due to reduction of D associated with the absence of the UCS during extinction.

A later study (Spence, 1966a) was to demonstrate that extinction carried out in the absence of the UCS was significantly faster than when either a delayed UCS or explicitly unpaired CS and UCS (cf. Rescorla, 1967) procedure was employed in the cognitive masking situation.

Performance of the CS-alone group was attributed to a rapid reduction of D. When extinction involved presentation of the UCS, however, D was sufficiently maintained to retard the process. Overall group means of the two extinction procedures involving presentation of the UCS did not differ significantly. However, the group with delayed UCS showed an initial extinction rate that was greater than the unpaired CS-UCS condition.

In usual conditioning procedures a delayed UCS had failed to demonstrate evidence of reinforcing CRs during extinction (McAllister, 1953; Reynolds, 1958; Spence, Rutledge and Talbot, 1964). Goldstein (1962), however, reported that within the cognitive masking procedure a delayed UCS was sufficient to maintain asymptotic performance in approximately one-third of the Ss. This suggested that a delayed UCS provided sufficient reinforcement of CRs to account for a greater resistance to extinction than in the CS-alone condition. However, this failed to explain why continuously reinforced Ss had shown significantly more rapid extinction than partial reinforcement groups in the delayed UCS procedure. It was apparent, however, that the delayed UCS method was not satisfactory for the maintenance of D to the exclusion of other factors. In addition, this tended to suggest that the degree of conditioning possible with ISIs up to

2500 msec. (Prokasy, 1965) is perhaps augmented by the serial nature of the SL and CS (Williams, 1965).

Spence (1966a) reported only 20% eyeblinks within the CR period following SL on PL-alone trials. However, Wickens (1959) has suggested that significantly greater levels of conditioning are possible to the initial, long duration component of a compound stimulus as a result of "sensory conditioning" between stimulus components. Simply, the initial component not only elicits the UCR associated with it, but this response becomes conditioned to the UCR of the second component. Thus, the initial component is capable of eliciting the necessary proprioceptive responses for conditioning CRs associated with the compound.

One study in the cognitive masking situation (Berman, Williams and Schneiderman, 1967) has shown that eyeblinks to the SL evidence acquisition and extinction functions similar to those of CRs. Ss received 21 continuously reinforced acquisition trials employing infraorbital shock as the UCS. Extinction involved 21 trials of the CS alone. CRs were recorded during the interval 200 - 500 msec. following the CS during acquisition but the interval was extended to 1200 msec. during extinction. After 12 acquisition trials slightly more responses were given to the SL-CS complex than to the SL alone. However,

these differences were never significant over the entire acquisition period. During extinction Ss responded less frequently to the SL than to the SL-CS. Although these differences were significant, extinction was slow and proceeded in a parallel fashion for both the SL and SL-CS complex. The authors suggested that, since CRs to the SL and CS showed similar acquisition and extinction functions, previous results may have been more appropriately interpreted by other theories than Spence's inhibitory set hypothesis.

Commenting on the unpaired CS and UCS extinction procedure, the authors argued that the temporal contiguity of the SL and CS during acquisition may have led to a stimulus compounding in which the SL served as a warning or ready signal for the CS-UCS presentations. However, it had been argued (Spence, 1963; Spence, Homzie and Rutledge, 1964) that the cognitive masking procedure failed to affect the process of acquisition. On the other hand, results of these and one study (Spence, 1966b) had evidenced noticeable response decrements associated with the cognitive masking procedures.

If assumptions of stimulus compounding are true, it is not unlikely that the usual ISI functions relating the CS to UCS may have been altered sufficiently to produce lower acquisition performance. That Ss have usually

emitted more responses to the SL-CS complex rather than the SL alone (Berman et al., 1967) may be interpreted as evidence that the relevant predictors of the UCS are emphasized over repeated trials (Prokasy, 1965). Procedural differences may have made the Berman et al. (1967) study incompatible with previous research. However, the authors concluded that more information regarding the nature of the SL-CS complex and its components would be necessary before results from the cognitive masking procedure provided sufficient confirmation of Spence's inhibitory set hypothesis. This conclusion was also voiced by Ross, Wilcox and Mayer (1967) after examining data from a differential conditioning study collected within the cognitive masking procedure.

Ross had previously concluded that inhibitory factors played an important role in extinction as the result of a study comparing performance of mental retardates and normals (Ross, Koski and Yeager, 1964). One-half of the normal sample served in a distraction task which involved the viewing of a motion picture during the conditioning procedure. All Ss received 50 acquisition trials involving either continuous or partial reinforcement for each of 2 days and 10 acquisition followed by 40 extinction trials on the third day. Nonreinforcement consisted of presentation of the CS alone during both acquisition and

extinction.

Results at the end of acquisition showed no partial reinforcement decrement in the case of the mental retardate sample. In fact, both reinforcement groups performed at a level almost equivalent to the continuously reinforced normal sample. The distraction task had no significant effect upon acquisition performance for the normals. However, partially reinforced Ss showed the usual significant performance decrement over the 110 acquisition trials. If allowances for final acquisition levels were made, partially reinforced Ss in the normal sample evidenced superior resistance to extinction. Although not significant, Ss viewing motion pictures showed less resistance to extinction than did Ss conditioned in the absence of the distraction task. Extinction performance of the mental retardates showed no effect of the schedule of reinforcement. Both continuous and partial groups showed greater resistance to extinction than did either of the normal groups. The authors interpreted the lack of PRE as evidence of the possibility that inhibitory factors resulting from higher-order processes were less operative in mental retardates than in normals.

Results from experiments with animals typically evidence no PRE and sometimes require as many extinction as acquisition trials before the classically conditioned

defense responses evidence extinction. Spence (1966b) interpreted these facts as evidence that higher-order, cognitive factors played less of a role in extinction of animals than humans. The results from Ross, Koski and Yeager's (1964) study were interpreted by Spence and Platt (1967) as the possible relation of the PRE to the capacity of Ss to make effective use of cognitive, mediating activities. Since mental retardates typically show evidence of deficiencies in verbal mediation tasks, it was assumed, apparently, that cognitive variables would not affect the extinction process in a sample of these Ss. This in fact may have been the case. Although the mean age of the retardate sample was 20 years, the average mental age was less than three years. The severity of their handicap would indeed have influenced their performance; perhaps to a degree that they replicated the typical performance of animals. It is questionable that the cognitive masking procedure influences cognitive processes to the same degree, however.

Stimulated to a degree by the results of previous research and the conclusions of Ross, Koski and Yeager (1964), a study of the effects of partial reinforcement in the cognitive masking procedure was conducted by Spence and Platt (1967). A continuously reinforced group of Ss received 59 reinforced acquisition trials. A partial

reinforcement group received 119 conditioning trials, 59 of which were reinforced. The reasoning behind this was to attempt to equate the number of reinforced presentations of the CS and stimulus traces of previous trials for both groups. Nonreinforcement, however, consisted of a delayed UCS presented 2500 msec. following onset of the CS. Thus, the partial group received twice as many UCS presentations as did the continuously reinforced Ss. Extinction involved 70 trials in which the CS was presented alone interspersed with 70 unpaired UCS presentations during 140 PL trials.

Acquisition performance of the two reinforcement groups did not differ significantly. This result was compared against the usual 30% - 50% decrement resulting from partial reinforcement. Since the number of reinforced trials was equated between groups, it was concluded that "a delayed UCS trial [in the cognitive masking procedure] appears to be entirely neutral in its effects, leading to neither an increment or decrement in CR frequency, as far as group data are concerned [p. 262]". This contrasts strongly with the conclusions of Goldstein (1962) and Spence (1966b) that a delayed UCS provided reinforcement during the extinction period. Although one-third of Goldstein's Ss maintained asymptotic performance throughout extinction, Spence and Platt

(1967) accepted these and the present data as confirmation of the neutral effects of the delayed UCS.

Extinction rates of the two groups failed to differ as well. Both groups showed approximately a 50% decrement in the first 15 extinction trials and after 70 trials both groups were performing at a level close to 40% of terminal acquisition. The lack of PRE and relatively slow extinction rates were taken as evidence of the absence of cognitive factors and resulting inhibitory set within the masking procedure. It is important, however, to recognize that the delayed UCS procedures employed under these conditions did not apparently affect performance as it did in standard conditioning situations. On the one hand, the authors argued that a delayed UCS was neutral with regard to its effects upon acquisition performance, yet proposed that it did not provide for non-reinforcement during the extinction phase. The unpaired CS-UCS procedure was adopted to avoid problems of nonreinforcement effects, but whether conditions omitting the UCS lead to equivalent results is an important question.

So far, Goldstein's (1962) study has alone concerned itself with the PRE employing CS-alone trials within the masking procedure. The argument that temporal relations of the SL and CS provide a compound stimulus and explicitly unpaired CS-UCS presentations allow for conditioning of a

stimulus component of the compound is hypothetical. Tentative confirmation of these propositions has come from one study (Berman, Williams and Schneiderman, 1967), however.

By means of a summary, the cognitive masking procedure involves the combination of two conditioning tasks serially presented to Ss. Previous research has shown that both acquisition and extinction performance in eyelid conditioning has been affected by the addition of the PL task. Of specific interest has been the fact that the schedule of reinforcement during acquisition has failed to affect rates of extinction within the procedure. Spence has interpreted the absence of the PRE in this situation as evidence that the procedure eliminated or reduced the effects of higher order processes in extinction. It is argued that, with the cognitive factors removed, extinction develops as a function of the accumulation of response inhibition as predicted by classical behavior theory. Such assumptions are not, however, necessitated from these data.

The propositions of expectancy theory hold that subjective predictions of the CS-UCS contingency developed during acquisition influence the ease with which counter-expectancies are developed during extinction. The degree of discriminability between conditions of uniform reinforcement and uniform nonreinforcement is greatest and

counterexpectancies of extinction developed quickly. The less rapid extinction of partially reinforced Ss is likewise attributed to a lower degree of discriminability between experimental procedures. Incorporating any procedure which reduces the possibility of immediately recognizing the shift from acquisition to extinction would lead to slower rates of extinction following continuous reinforcement. However, this effect need not be due to the lack of cognitive involvement but rather a function of the degree of difficulty in noticing the change in experimental conditions. That is, as the shift between procedures is less noticeable, new expectancies and response strategies are developed less quickly.

It is obvious that the inclusion of the PL task greatly influences performance. However, that such a task effectively eliminates higher-order processes may not be a warranted assumption. The absence of the PRE within masking procedures may result, instead, from a greater degree of difficulty in noticing the shift from uniform reinforcement to the extinction procedure. Equal rates of extinction following continuous and partial reinforcement within this procedure need not be due to the elimination of cognitive factors.

Effects of UCS Intensity

There is little empirical evidence relating the

effects of UCS intensity to conditioning in the cognitive masking procedure. Theories which have been presented have postulated the effects of UCS intensity within standard conditions. Application to the cognitive masking procedure may be proceeding beyond the bounds of these theories. However, there is limited evidence (Spence and Platt, 1966; Bernstein and Rutledge, 1969) that these propositions hold in particular situations.

In standard conditioning situations, the frequency of CRs has usually assumed a positive function of the UCS intensity. According to classical behavior theory (Hull, 1943; Spence, 1956, 1958), $\underline{D}$ is assumed to be a monotonic and increasing function of UCS intensity. In addition, $\underline{H}$ may show greater increments with increased UCS intensity as a function of increased drive reduction (Spence, 1958). Thus, as the UCS intensity increases, $\underline{D}$ and $\underline{H}$ and the resultant excitatory potential are incremented. Since $\underline{E}$ is assumed to be a positive function of the probability of a response, the frequency of CRs is likewise assumed to increase with increments of UCS intensity. It should be noted, however, that while this theory seems to hold for higher UCS intensities, there is apparently a threshold below which variations in the UCS have little effect (Ross and Spence, 1960).

Within expectancy theory the relation between UCS

intensity and performance is, at least, more tentative. According to Tolman (1952) learning occurs through repeated confirmation of expectancies rather than through drive reduction. Rewards and punishments serve to emphasize expectancies and means-end relations and tend to influence performance only as they make the expectancies more salient. Thus, prediction of the effect of increased UCS intensity are only valid on the basis of subjective expectancy and the possible effects on sign-significate relations. Because of this tentative nature, most statements of the effects of UCS intensity are post hoc, if made at all.

Allied to expectancy theory are a variety of two-factor theories best exemplified by the propositions of Prokasy (1965) and Rescorla (1967, 1969). Both authors propose that classical conditioning consists of the association between the occurrence of the CS and UCS. Degree of learning is governed by the temporal contiguity or degree of dependency between the two events rather than the frequency of occurrence. The temporal relation between the CS and UCS is termed the classical contingency. The relationship between the CR and the presentation of the UCS represents another contingency, of an instrumental nature. The classical and instrumental contingencies are not assumed to be independent so that events which affect the former may evidence themselves in effects upon the

instrumental contingency. Foth and Runquist (1970) have argued that if a classical contingency is established, manipulation of the UCS intensity should effect performance to the extent that the presentation of the UCS is predictable from the CS. This leads to the prediction that as the CS-UCS contingency is increased, or the predictability of the UCS improved, effects of increasing the UCS become greater.

Experiments involving continuous reinforcement. Several studies (Spence, 1953; Spence, Haggard and Ross, 1958; Prokasy, Grant and Meyers, 1958; Ross and Hunter, 1959) have provided results supporting the monotonic function between the frequency of CRs and UCS intensity when acquisition involves continuous reinforcement. Two studies (Spence and Platt, 1966; Bernstein and Rutledge, 1969) have compared the acquisition performance of continuously reinforced Ss in the cognitive masking situation under two UCS intensities. Both studies found that the higher UCS intensity led to significantly more CRs than did the lower intensity. This result is typical of findings from experiments involving standard conditions. The authors concluded that the relation between UCS intensity and performance in the masking procedure was equivalent to that in the standard procedures. That is, under continuous reinforcement, as UCS intensity increases performance

tends to follow a positive increasing function.

Experiments involving partial reinforcement. The results from studies of the effects of UCS intensity upon performance under schedules of partial reinforcement are less consistent. Ross and Spence (1960) concluded that while a positive monotonic function described data under continuous reinforcement, the relation between UCS intensity and performance under partial reinforcement was best described by an S-shaped function. Performance over the lower end of the function appeared to vary little. However, above an intensity threshold performance was assumed to be a monotonic function of UCS intensity. A number of studies have produced evidence that has argued against the validity of this assumption.

Runquist (1963) reported that performance of a 50% partial reinforcement group conditioned under a low UCS intensity was slightly greater than that of the stronger intensities. When the trial-to-trial performance of Ss was compared, Runquist concluded that response inhibition resulting from nonreinforcement was greater for the strong UCS intensity. A later study (Boice and Boice, 1966) reported findings in support of Runquist's results. The authors found that a group receiving a weaker UCS intensity emitted more CRs than one presented a stronger UCS.

A study comparing the effects of UCS intensity upon

three schedules of 50% partial reinforcement was reported by Foth (1968). When the schedule of reinforcement was random, versus double alternation or run biased, superior (but not statistically significant) performance was noted under the weaker of two UCS intensities. Although performance in the run biased condition was superior under the high UCS intensity, no effect of UCS intensity was found in the double alternation group when considered over all trials. Ss in both patterned reinforcement groups did, however, tend to emit more CRs on reinforced trials under the higher UCS intensity than when the low UCS intensity was employed. No effect was noted when the frequency of CRs on reinforced and nonreinforced trials was compared between UCS intensities in the random partial reinforcement group.

An S who responded to the event sequence of the double alternation schedule by demonstrating a greater probability of a CR on a reinforced trial than a nonreinforced trial was defined as a "double alternator" after the criterion of Prokasy, Carlton and Higgins (1967). Patterned responses of this type were assumed to evidence the effects of instrumental contingencies within the reinforcement schedule. Foth (1968) found that more than twice as many Ss could be identified as double alternators under the higher UCS intensity than

the lower. While there was no evidence of differential response increments or decrements resulting from reinforced or nonreinforced trials, the higher UCS intensity apparently made the pattern of reinforcement more salient in the case of the double alternation group (Foth and Runquist, 1970). The effects of UCS intensity in the non-random schedules were interpreted as a function of the predictability of the UCS: "The degree to which the instrumental contingencies of the UCS occurrence gain control of responding could depend upon the degree to which the UCS is predictable from the occurrence of a CS [Foth and Runquist, 1970, p. 247]." By nature of the event structure, the classical contingencies of a random schedule of reinforcement do not provide effective prediction of the UCS. Thus, instrumental factors tend to be minimal and increments resulting from increased UCS intensity would be expected only in special cases.

Results of an unpublished study in the University of Alberta laboratory², in conjunction with the summary provided by Ross and Spence (1960), add support to these conclusions. The former study employed five groups of Ss, all conditioned under 50% random partial reinforcement, varying the intensity of the UCS. The group receiving the lowest UCS intensity [20-mm. of mercury (Hg)] showed the lowest conditioning of all groups. A

comparison between the remaining groups (50- to 160-mm/Hg) showed that, although they demonstrated significantly more CRs than the 20-mm. group, they did not differ among themselves. Ross and Spence (1960) reported that although a significant increase was noted when the UCS intensity was elevated from 45- to 100-mm/Hg, over the lower range (20- to 45-mm/Hg) no significant differences in the frequency of CRs were noted. Taken together, these results suggest the existence of a threshold intensity which is necessary to produce conditioning under partial reinforcement. Variations in UCS intensity above or below the threshold fail to produce significant effects upon performance. Thus failure to find effects of UCS intensity in previous studies may be due to the fact that all values employed were above the necessary threshold.

Effects of ready signals. The data of Ross and Spence (1960) comparison were based on studies which incorporated a delayed UCS on nonreinforced trials and a ready signal preceding presentations of the CS. The threshold intensity postulated here would be assumed to lie somewhere between 45- and 100-mm. for their data. Evidence from a more recent study², employing omitted UCS on nonreinforced trials and no ready signal, suggested a threshold within the range of 20- to 55-mm/Hg and results from Foth's random group would locate the threshold somewhere below 50-mm/Hg.

However, 50-mm/Hg proved to be insufficient in the case of Foth's (1968) double alternation and run biased groups. It is apparent that variations in the conditioning procedure affect the influence of UCS intensity; specifically the threshold necessary for conditioning. Two important factors appear to be the predictability of the UCS and the presence of a signal preceding conditioning trials.

At the same UCS intensity, groups conditioned in the presence of a ready signal have typically shown a significant decrement in the frequency of CRs (Beecroft, 1966; Kimble, 1967). It has been suggested that the ready signal affects performance in one of two ways; response latency or CR inhibition.

Goodrich (1964) has suggested that the inclusion of a ready signal produces more frequent short-latency responses excluded as CRs on the basis of an alpha response latency criterion. In opposition, Dufort and Kimble (1958) proposed that the ready signal served as an external inhibitor to the CS producing a reduction in the frequency of CRs. In fact, both of these hypotheses may be true. However, support of the effects upon response latency seem to be the strongest (Beecroft, 1966).

It has been argued that the SL within the cognitive masking situation serves as a ready signal to CS onset. Tentative support of the proposition may be drawn from

two sources. First, there is evidence of the acquisition and extinction of eyeblinks to the SL in a fashion similar to that of responses to the CS (Berman, Williams and Schneiderman, 1967). Secondly, when compared to Ss within a standard procedure those within the masking procedure have shown substantially lower acquisition performance at the same UCS intensity (Spence, 1963; Spence, Homzie and Rutledge, 1964). This suggests that a UCS intensity sufficient to evidence asymptotic performance in the standard conditions is less than that required within the masking procedure. However, the question of what within the task is responsible for this effect remains unanswered.

In the present experiment a procedure which maintains the SL-RL and CS-UCS contingencies, but attempts to avoid stimulus compounding, is compared against the original masking procedure. Within the original procedure SL may acquire properties of a ready signal or form a compound stimulus with the CS. The modified procedure hopefully avoids this possibility. In one respect the two procedures may be considered as conditioning tasks including and excluding the presence of a ready signal. On the basis of previous comparisons, an interesting investigation would be to ascertain if superthreshold intensities found in a signal-free situation would prove to be insufficient to

evidence conditioning in the original masking procedure. There is little evidence available upon which to base the selection of intensities. No previous masking procedures have considered the effects of UCS intensity upon performance under schedules of partial reinforcement. However, it appears safe to assume that intensities sufficient to produce conditioning in previous studies conducted under standard conditions in the Alberta laboratory should prove sufficient within the modified masking procedure. The important question is whether these intensities prove effective within the original masking procedure.

Statement of Problem

The character of the current research is best described as exploratory. A variety of studies, all employing similar procedures, have led to the development and support of propositions regarding the factors governing extinction. Previous results have been interpreted as offering support for the proposition that higher-order processes may be effectively eliminated by the inclusion of a secondary prediction task in an eyelid conditioning procedure. The general aim of this study is to consider whether such a proposition is warranted. Specifically, the present study attempts to examine the following questions:

- (1) Are previous results due solely to the inclusion of the PL task or are they dependent upon the specific character of event sequences in the original masking procedure?
- (2) Are the effects of UCS intensity influenced by the conditioning procedure in a manner similar to that of CS-UCS predictability?
- (3) When nonreinforcement involves elimination of the UCS, are previous acquisition and extinction results replicable?
- (4) Is the proposition that higher-order processes can be eliminated within the original masking procedure justified, or may previous results be due to the effects of other variables?

The scope of this research is not sufficient to test the validity of Spence's discrimination hypothesis of extinction. As it parallels predictions of expectancy theory, the presence of PREs tends to support either position. However, support for the assumptions regarding control of higher-order processes by inclusion of the PL task is gained to the extent that current results replicate previous findings. Contradictions tend to place doubt upon the assumption that cognitive processes are unnecessary in the acquisition and extinction of simple conditioned responses.

METHOD

Subjects

The Ss were 166 volunteers from Introductory Psychology classes at the University of Alberta who participated in the experiment to fulfil course requirements. No S had previously served in eyelid conditioning or probability learning experiments. The data of six Ss were discarded; three on the basis of technical difficulties with the apparatus, two because of experimenter errors and one because of an unwillingness to complete the experiment. No Ss were eliminated because of meeting a voluntary response criterion on conditioning trials.

The remaining 160 Ss - 64 males and 96 females - were assigned haphazardly to experimental conditions in the order of appearance at the laboratory except when it became necessary to equate the number of males and females in each condition.

An additional 10 Ss from Introductory Psychology classes were run under one experimental condition (OM-P-50) to examine the possibility of a sampling error determining the original results.

Apparatus

The conditioning laboratory occupied two adjoining rooms in Assiniboia Hall at the University. Programming

and recording apparatus was located in a room separate from the experimental room. The experimental room contained two 3- x 5-ft. experimental booths each with a wooden semicontour arm-chair in which an S sat during the experiment. The inside of the booths were painted flat white and each illuminated by a 25-watt incandescent bulb which provided a homogeneous illumination of 0.1 ft.-candles along the surface of the booth which S faced. Though separated from the apparatus room by sound-proofing, a Travel Aire 830 Air Cooler was turned on during the experiment to provide a constant background masking noise.

Three lamps employed in the probability learning (PL) task were mounted on a panel in each booth facing the S. Two 24-vdc pilot lamps with yellow filters were placed on a plane horizontal to the seated S's eyelevel and approximately 4 ft. in front of him. The 3- x 5-in. glass screen of an IEE Model 80000 visual display unit was centered between the two outside lamps. Illuminating the centre screen to 1.46 ft.-candles for 2500 msec. served as the signal light (SL) of the PL task. The response lights (RL) consisted of illuminating either of the pilot lamps to 5.25 ft.-candles for 800 msec.

Ss held a photoswitch in each hand with which they indicated their predictions during the PL trials. Latch-

ing relays allowed for only one response to be considered during the SL period and E_1 predictions (A_1 responses) were recorded in blocks of 10 trials with a Hunter model 145 Printout Counter.

The CS was a 500-cps tone from a Jackson Model 655D Audio Oscillator presented for 2500 msec. to each S through a pair of Telex HDP-53A stereo headphones. An 80-msec. static air puff of compressed commercial grade-G nitrogen delivered through a 0.5-mm. orifice to the S's right eye at an angle 45° off his normal straight line of vision defined the UCS.

Headsets recording the eyeblinks and delivering the UCS consisted of a foam padded adjustable band to which a microtorque potentiometer with rotating armature was mounted. A false eyelash, attached to the armature of the potentiometer with a thread, was positioned on the S's right eyelid by means of adhesive tape. Movements of the eyelid affected a resistance variation through the potentiometer which was amplified and recorded on a two channel Brush Mark II Ink Writing Oscillograph. An auxiliary bridge circuit provided adjustment of the recording pen bias and amplification was set at 0.2-v/mm deflection of the recording pens. A constant 12-vdc current through the potentiometer was maintained by a Harrison Model 6433B power supply. Resistance through the system

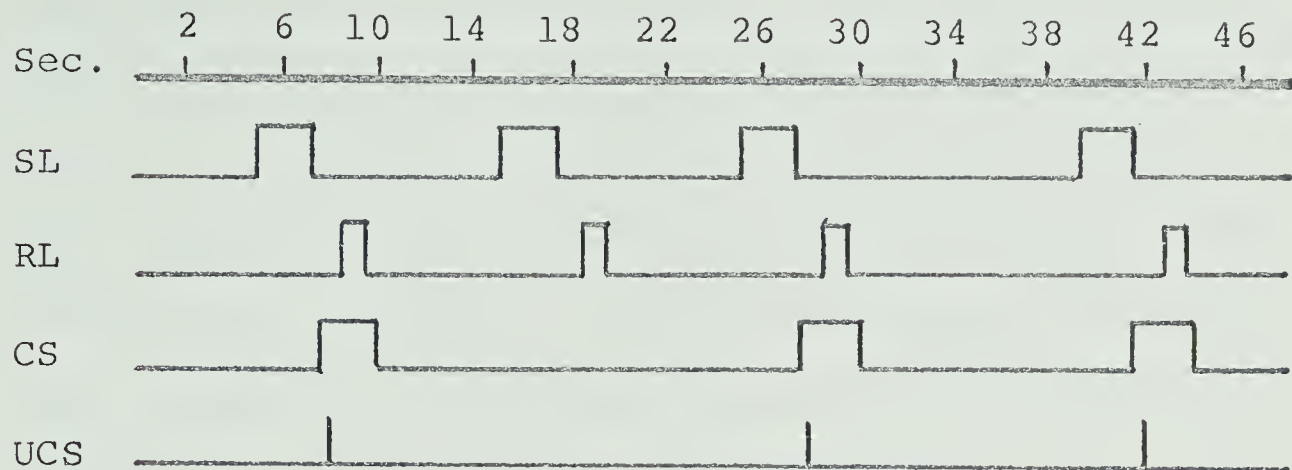
was approximately 1500 ohms when the S's eye was open. Onset of the CS and SL were recorded by event markers of the Brush Oscillograph concurrently with the eyeblink responses at a paper speed of 25-mm/sec.

Experimental trials were programmed with punched tape and read by a Convair Tape Transmitter driven by a 12-vdc synchronous motor. Events within trials were controlled by a series of electromechanical relays and Hunter 111-D and 116-C Interval Timers.

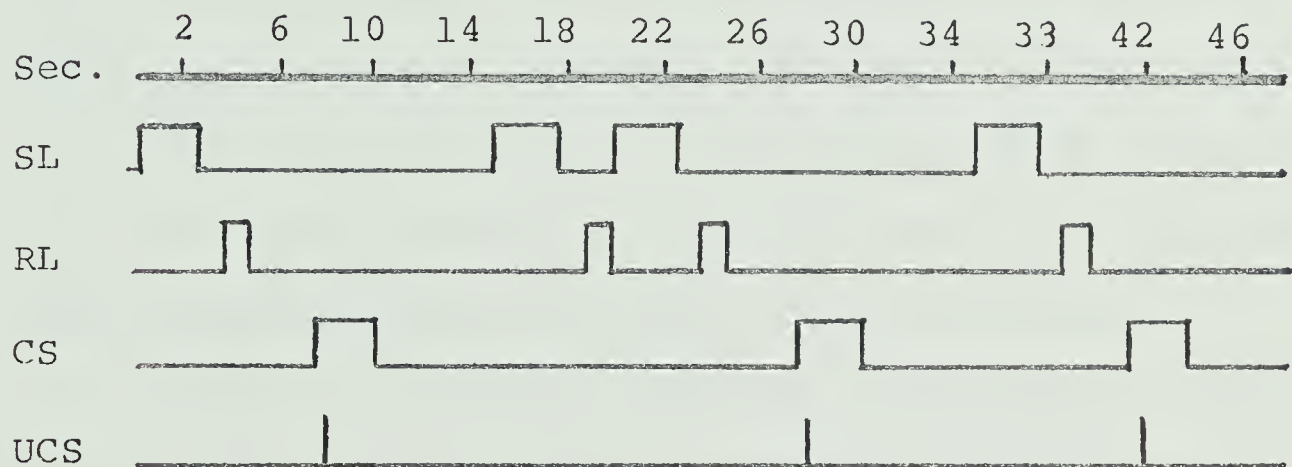
Design

The experimental design varied parameters of probability learning and conditioning programming, schedules of reinforcement, and UCS intensity within a 2 x 2 x 2 factorial design. One half of the Ss were presented a schedule of PL and conditioning trials replicating the temporal components of Spence's (1963) original masking procedure (OM). In this condition PL and conditioning trials were programmed in a tandem fashion exemplary of the serial conditioning paradigm described by Williams (1965). The remaining Ss served in a condition which, while maintaining SL-RL and CS-UCS intervals, involved the concurrent scheduling of PL and conditioning trials. The two procedures are perhaps best compared by examination of Figure 1.

Under the OM procedure the SL of PL trials was pre-



ORIGINAL MASKING (OM) PROCEDURE



MODIFIED MASKING (MM) PROCEDURE

Figure 1: Comparison of the temporal relations between components of the two cognitive masking procedures. The upper panel describes the adaptation of Spence's (1963) procedure and the lower panel a modification of the original temporal components. SL and RL refer to components of the PL task as described in the text.

sented and followed, after a 1-sec. delay, by the lighting of one of the two RLs. CS onset coincided with the turning off of SL on conditioning trials. Intertrial intervals (ITI) for conditioning trials were equated between the OM and modified masking (MM) procedures. However, in the MM procedure, PL trials were arbitrarily placed between conditioning trials. Restrictions imposed upon the programming of PL trials in this procedure were that ITIs be equated between the OM and MM procedures for blocks of 10 trials and that no conditioning trials begin within the interval 5-sec. following or 5-sec. preceding a PL trial. The latter restriction was imposed to avoid the possible confounding of SL and CS in conditioning trials and the interpretation of original eyeblink responses to the SL as CRs.

Within each masking procedure parameters of schedule of reinforcement and UCS intensity were also varied. Ss were either conditioned under schedules of continuous (C) or 50% partial (P) reinforcement. A reinforced trial was defined as the presentation of the UCS 500-msec. after CS-onset. Unlike Spence and Platt's (1967) procedure, nonreinforced trials involved the presentation of the CS alone. The schedule of reinforced and nonreinforced trials for the partial reinforcement groups is presented in Appendix A. This schedule was balanced so that five

reinforced trials occurred within each block of 10 conditioning trials with transitional probabilities between reinforced and nonreinforced trials constant for blocks of 30 trials.

UCS intensity was measured at the source by means of a mercury manometer in terms of pressure necessary to support a column of mercury (Hg) 50-mm. in height for the weak and 150-mm. in height for the strong intensity conditions.

Procedure

Upon arrival at the laboratory Ss were met by the E, accompanied to the experimental room and seated in the arm-chairs. E explained that a headset used to record eyeblinks and a set of headphones would be placed on S's head. After E positioned the headset and attached the potentiometer, S was provided the photoswitches to hold in his hands. A set of neutral instructions were read to Ss over an intercom system between the apparatus and experimental rooms. Appendix B presents a copy of the instructions employed for all Ss.

A set of four PL trials were then presented to the Ss in which the order of events was E_1 , E_1 , E_2 , and E_2 . The experimental procedure began immediately after Ss had read the remaining instructions following the practice trials.

Each S received 120 conditioning trials consisting of 90 acquisition and 30 extinction trials. The mean ITI for conditioning trials was 20 sec.; varying from 15 - 25 sec. All Ss participated in 240 PL trials. For the OM procedure 120 trials were programmed concurrently with conditioning trials and 120 trials were presented in the absence of either the CS or UCS. Conditions under the MM procedure received 240 PL trials which were separated from CS and UCS presentations by at least 5 sec. Mean ITIs for the PL trials of both masking conditions were 10 sec.; varying between 5 and 15 sec. Thus, in both procedures, Ss received the same number of PL and conditioning trials at identical rates of presentation.

RLs were random orders of E_1 and E_2 so that within a block of 10 trials the ratio was 7:3, respectively. A restriction was applied to the generation of orders so that within a block of 10 trials E_1 did not occur in more than four successive trials. Three interblock transitions showed E_1 in a series of five successive presentations, however.

For all conditions extinction consisted of 30 non-reinforced (CS-alone) trials. A CR was recorded whenever the recording pen showed a deflection of 1-mm. or more during the interval 150- to 500-msec. following

onset of the CS. Responses occurring within the interval 0- to 150-msec. after CS onset were recorded as alpha-type responses. Responses initiated within the "alpha" period and recovered for CRs were tabulated separately but eliminated from the counts of CRs for the analyses.

RESULTS

The frequency of alpha-type, recovered short-latency, and CRs were tabulated for blocks of 10 acquisition trials and proportions formed. The mean proportion alpha-type responses for each of the eight experimental conditions over the 90 acquisition trials exceeded 0.10 in only one case; for the recovered short-latency responses means never exceeded 0.06. Both response types evidenced their greatest frequency in the initial trial blocks, showed some reduction over the remaining trials, but their means rarely exceeded 0.07 over the last 60 acquisition trials. In the light of these data it seems reasonable to interpret these as competing responses to the acquired CR which would be expected to disappear as conditioning proceeded (Kimble, 1961). However, there was no indication that these responses were reinstated during the extinction period.

CRs Acquisition

Conditioning curves over the 90 acquisition trials are presented in Figure 2 for all groups. The performance of group OM-P-50 is most outstanding in this figure and would be reasonably assumed to be the result of a sampling bias. However, results of an additional sampling of Ss failed to differ from the mean performance of this

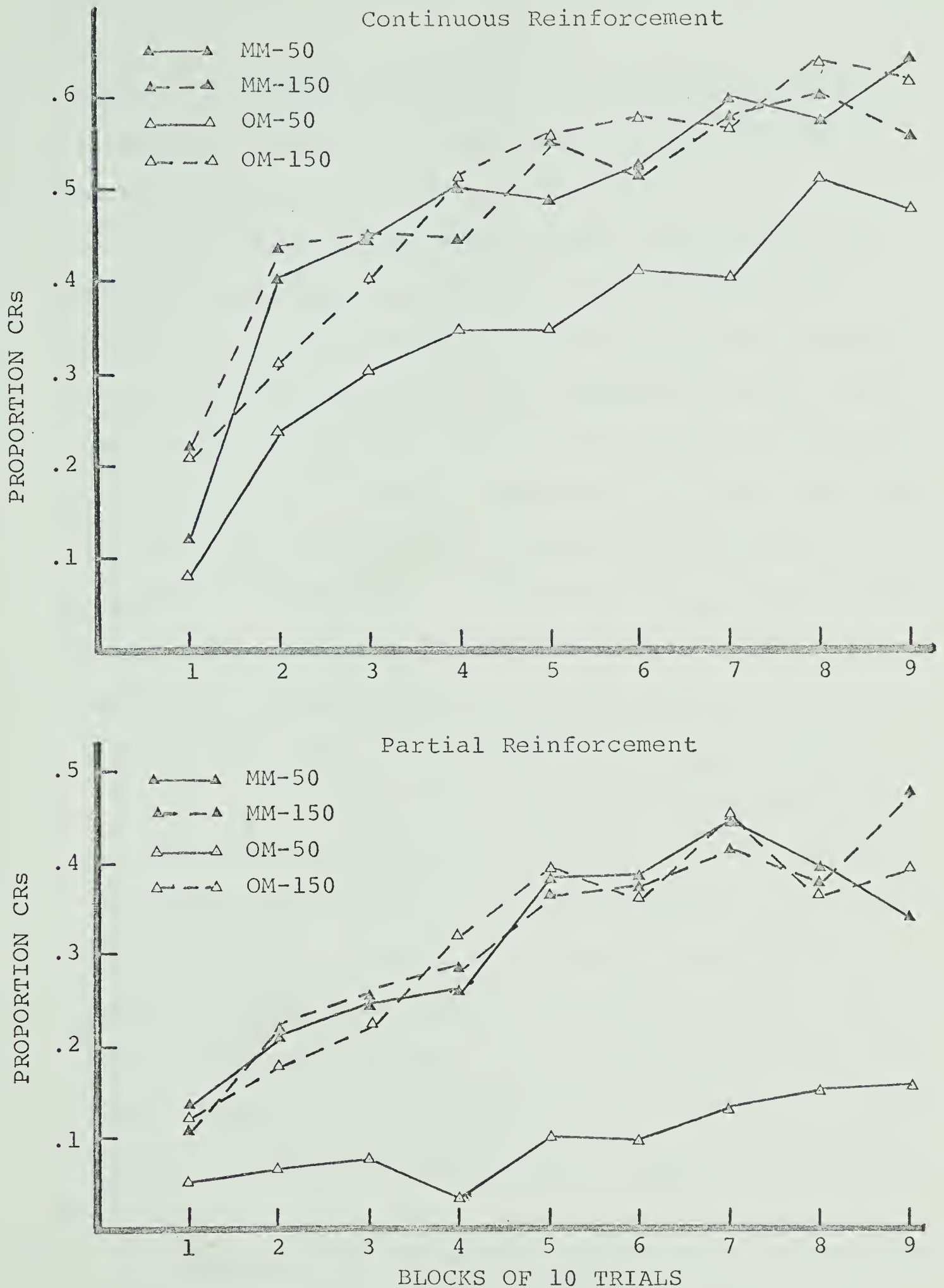


Figure 2: Proportion CRs emitted under original masking (OM) and modified masking (MM) procedures for 50- and 150-mm/Hg UCS intensities within blocks of 10 acquisition trials.

group. Therefore, performance of this group must be assumed to represent the influence of the combination of experimental conditions.

In relation to the other groups, performance of OM-P-50³ suggested the presence of heterogeneity of variance. It is reasonable to assume that the assumption of equality of covariances over repeated measures (Winer, 1962) would not be met in the steep acquisition period of the initial trial blocks. However, if groups were homogeneous, this should be evidenced in the periods of asymptotic performance. Therefore, an $F_{\max}$ test (Winer, 1962) was conducted between the eight groups using the variances of proportion of CRs over the last 30 acquisition trials and proved significant; $F_{\max} (7,19) = 5.34$, $\underline{p} < .01$. This heterogeneity was due principally to the performance of group OM-P-50 as a test over the remaining seven groups was not significant; $F_{\max} (6,19) = 1.98$, $\underline{p} > .05$. In view of the heteroscedasticity of variance present, an arcsine transformation suggested by Winer (1962) was applied to the proportion CRs over all trial blocks. This transformation corrected the heterogeneity of asymptotic performance; $F_{\max} (7,19) = 4.11$, $\underline{p} > .05$.

Employing the transformed proportions, an analysis of variance was performed over the 90 acquisition trials.

Table I presents a summary of this analysis. It is interesting to note that application of the Greenhouse and Geisser (1954) correction for heteroscedasticity of covariances would not have altered the results. The conditioning curves clearly show the statistically significant effect of Reinforcement Schedule for both masking procedures. The performance of groups conditioned under continuous reinforcement was significantly higher than those of partial reinforcement groups. The effect of trials was both in slope and curvature as evidenced by the significant linear and quadratic trends presented in Table II.

The significance of the linear trend for Trials is evidenced by the general increase of CRs over the acquisition period while the quadratic component indicated a significant deviation from linearity; i.e., the plateau corresponding to asymptotic performance. The slope of the combined continuous reinforcement groups was steeper than that of partially reinforced Ss as indicated by the significant R x T interaction. However, this trend is qualified by the significance of the R x I x T linear trend. In general, the slopes of acquisition are equal between groups with the exception of the relatively unchanging curve for group OM-P-50. The performance of this group is markedly different from any other and,

Table I

Summary of analysis of variance performed upon transformed proportions of CRs within blocks of 10 acquisition trials

Source	SSQ	df	MSQ	F
Masking Procedure (M)	29.565	1	29.565	5.98*
Reinforcement Schedule (R)	119.192	1	119.192	24.12**
UCS Intensity (I)	37.759	1	37.759	7.64*
M x R	2.238	1	2.238	
M x I	25.536	1	25.536	5.13*
R x I	.344	1	.344	
M x R x I	.384	1	.384	
S (MRI)	751.174	152	4.942	
Trials (T)	112.706	8	14.088	64.67**
M x T	1.330	8	.166	
R x T	5.472	8	.684	3.14**
I x T	1.813	8	.226	1.04
M x R x T	1.107	8	.138	
M x I x T	1.900	8	.237	1.09
R x I x T	3.092	8	.386	1.77
M x R x I x T	1.558	8	.195	
Residual	264.901	1216	.218	

* $\underline{p}(\underline{F}) < .05$

** $\underline{p}(\underline{F}) < .01$

Table II

Analysis of variance of linear and quadratic components of trials and trial interactions during acquisition

Source	MSQ	df	F
<u>Linear Components:</u>			
Trials (T)	101.736	1	467.12*
Masking Procedure x T	.115	1	
UCS Intensity x T	.719	1	3.30
Reinforcement Schedule x T	2.369	1	10.87*
M x I x T	.416	1	1.91
M x R x T	.242	1	1.11
R x I x T	1.462	1	6.71*
M x R x I x T	.019	1	
<u>Quadratic Components:</u>			
T	9.484	1	43.54*
M x T	.468	1	2.15
I x T	.253	1	1.16
R x T	.788	1	3.61
M x I x T	.511	1	2.34
M x R x T	.140	1	
M x R x I x T	.847	1	3.88*
Residual	.218	1216	

* $p(F) < .01$

since trends between all other groups were not significantly different, it may be assumed to be the source of these interactions. Likewise, the significance of the $M \times R \times I \times T$ quadratic trend is attributable to the performance of this one group.

Returning to Table I, results of the analysis showed significant effects of Masking Procedure, Reinforcement Schedule, and UCS Intensity. The effect of Masking Procedure was differential with respect to the level of UCS intensity as evidenced by the significant $M \times I$ interaction. At 50-mm/Hg mean performance of groups under the MM procedure was significantly higher than groups conditioned within the OM procedure. However, at 150-mm/Hg differences between the procedures were negligible. In all instances performance of groups conditioned under a partial reinforcement schedule was markedly lower than those receiving continuous reinforcement.

A reasonable question is whether the effect was simply due to a differential frequency of reinforcement between conditions. If that were the case, equating performance in terms of the number of reinforced trials should eliminate the partial reinforcement decrement. To provide an answer to this question, mean proportion of CRs of 45 reinforced trials were calculated and an analysis of variance performed on these data. Results of the analysis, presented in Table III, are strikingly similar to those

Table III

Summary of analysis of variance performed upon
proportion CRs over 45 reinforced trials
of acquisition

Source	SSQ	df	MSQ	F
Masking Procedure (M)	.384	1	.384	6.52*
Reinforcement Schedule (R)	.386	1	.386	6.56*
UCS Intensity (I)	.335	1	.335	5.70*
M x R	.007	1	.007	
M x I	.279	1	.279	4.74*
R x I	.025	1	.025	
M x R x I	.020	1	.020	
S (MRI)	8.935	152	.059	

* $\underline{p}(\underline{F}) < .05$

of the overall analysis. The effects of Masking Procedure and UCS Intensity interacted as they did in the analysis over all trials. Of importance is the fact that, even when equated for the number of reinforcements, partial reinforcement groups showed a significant response decrement.

While indicating differences in overall performance, the data of these analyses include responses from periods of initial adaptation and response shaping and have been suggested as probably better excluded from experimental analyses (Prokasy, Carlton and Higgins, 1967). To examine the effects of experimental conditions, measures of asymptotic performance have been preferable in many instances. Results of an analysis of variance performed upon the transformed mean proportion of CRs over the last 30 acquisition trials are presented in Table IV. The main effects of Masking Procedure, Reinforcement Schedule, and UCS Intensity were again significant and in the expected direction. While failing to meet the 0.05 level, the M x I interaction was significant at the 0.10 level.

The mean proportion CRs over the last 30 trials of acquisition are presented in Figure 3 for all eight experimental conditions. Mean asymptotic performance under the MM procedure was significantly higher than that of the OM

Table IV

Summary of analysis of variance of transformed
mean proportion of CRs over last 30
trials acquisition

Source	SSQ	df	MSQ	F
Masking Procedure (M)	2.481	1	2.481	4.77*
Reinforcement Schedule (R)	13.402	1	13.402	25.78**
UCS Intensity (I)	2.798	1	2.798	5.38*
M x R	.434	1	.434	
M x I	1.886	1	1.886	3.62
R x I	.495	1	.495	
M x R x I	.082	1	.082	
S (MRI)	79.040	152	.520	

* $\underline{p}(\underline{F}) < .05$

** $\underline{p}(\underline{F}) < .01$

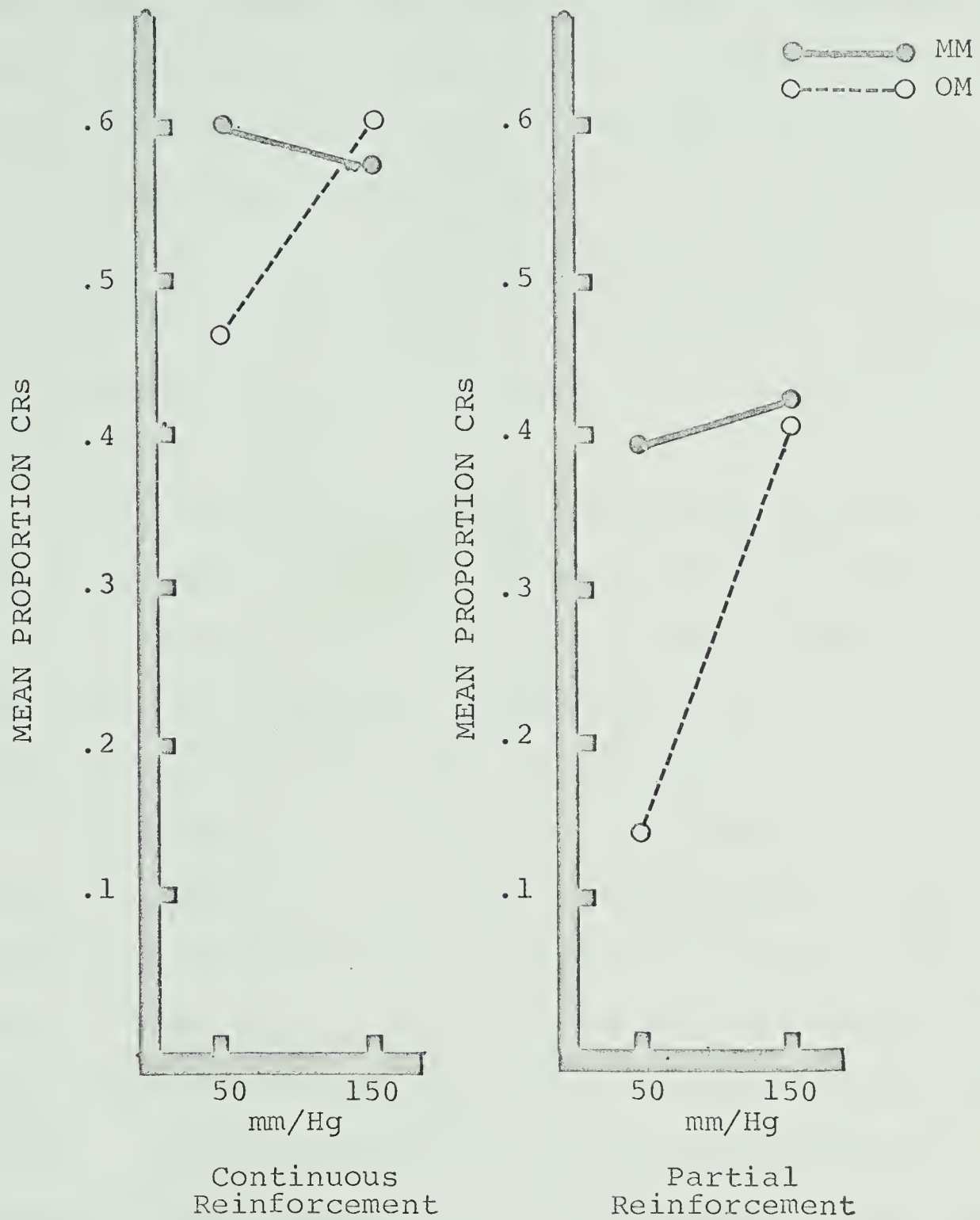


Figure 3: Mean proportion CRs emitted over last 30 acquisition trials under OM and MM procedures and 50- and 150-mm/Hg UCS intensities.

condition. However, the effect of Masking Procedure again proved to be differential with respect to the level of UCS intensity employed, although the $M \times I$ interaction failed to meet significance. Performance under the OM and MM procedures differed significantly at 50-mm/Hg [$t(152) = 3.03, p < .01$] while the comparison between procedures showed a negligible difference at 150-mm/Hg [$t(152) < 1.0$].

While performance of both reinforcement groups under the OM procedure showed an increase with the higher level of UCS intensity, it is interesting that neither conditions MM-C nor MM-P were significantly affected by the intensity of the UCS. The overall effect of the schedule of reinforcement was to increase the frequency of CRs under a schedule of continuous reinforcement. This effect was consistent and significant for both intensities of the UCS. In all, these results differed little from the analysis performed over the entire acquisition period. The only exception was the less pronounced effect of UCS Intensity for condition OM-C in this analysis.

It is apparent from these analyses that performance under both masking procedures is affected by the schedule of reinforcement during conditioning. The effect of UCS Intensity is, however, dependent upon the particular condi-

tioning procedures employed. The performance decrement evidenced by partial reinforcement groups was shown not to be solely the function of the frequency of reinforcement. Superior performance under the MM procedure is mainly attributable to the lack of a UCS intensity effect for both schedules of reinforcement. The absence of differences due to the UCS intensity under the MM-P procedure is consistent with previous research from this laboratory (Runquist, 1963; Foth, 1968). However, absence of the effect under schedules of continuous reinforcement for the MM procedure was somewhat unexpected on the basis of previous results.

CRs Extinction

Conditioned responses over the 30 extinction trials are presented in Figure 4. Trial 0 represents the proportion of CRs emitted over the last 10 acquisition trials and the remaining values along the abscissa of the figure are ordinal trials ending blocks of the extinction period. As for the data of the acquisition period, arcsine transformations of the proportion of CRs were obtained and employed in the analyses.

Results of an analysis of variance performed upon the transformed proportions are presented in Table V. The effect of Trials substantiated the general decrease in performance over the extinction period. The main

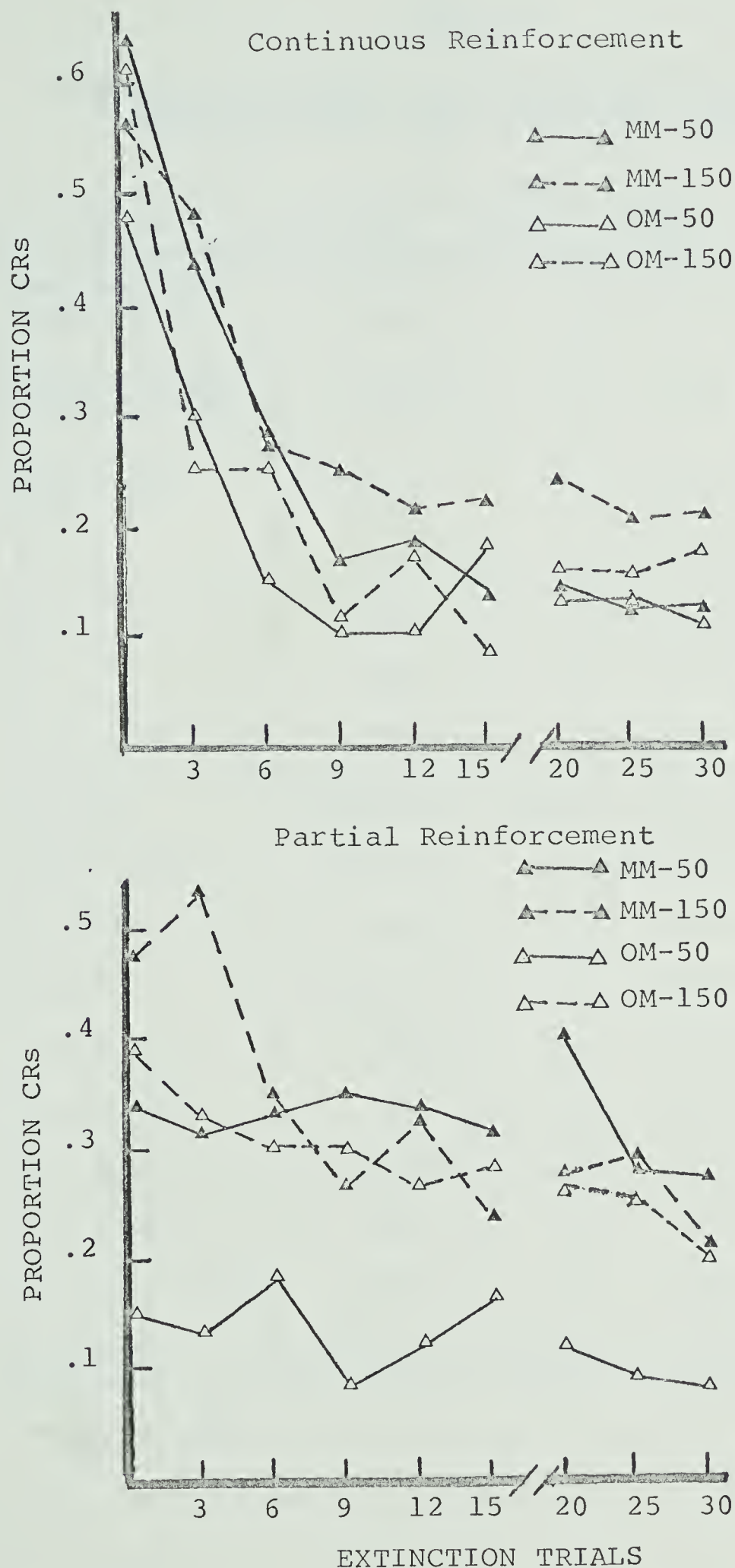


Figure 4: Proportion CRs emitted under the original masking (OM) and modified masking (MM) procedures and 50- and 150-mm/Hg UCS intensities over extinction trials.

Table V

Summary of analysis of variance of transformed
proportion CRs over extinction trials

Source	SSQ	df	MSQ	F
Masking Pro- cedure (M)	32.004	1	32.004	9.64*
Reinforcement Schedule (R)	3.845	1	3.845	1.16
UCS Inten- sity (I)	9.462	1	9.462	2.85
M x R	2.481	1	2.481	
M x I	2.456	1	2.456	
R x I	2.934	1	2.934	
M x R x I	6.985	1	6.985	2.10
S (MRI)	504.376	152	3.318	
Trials (T)	93.640	8	11.705	26.90*
M x T	4.659	8	.582	1.34
R x T	28.838	8	3.605	8.28*
I x T	3.660	8	.457	1.05
M x R x T	.814	8	.102	
M x I x T	2.685	8	.336	
R x I x T	3.832	8	.479	1.10
M x R x I x T	5.031	8	.629	1.45
Residual	529.163	1216	.435	

* $p(F) < .01$

effect of Reinforcement Schedule was not significant. However, examination of the curves suggested the possible source of this mean similarity over extinction trials. The apparent PRE in both masking procedures was verified by the significance of the $R \times T$ interaction and the nonsignificant $M \times R \times T$ interaction. Combining data over this significant interaction would have the effect of eliminating Reinforcement Schedule as a significant effect.

In both masking procedures continuously reinforced Ss demonstrated rapid extinction of the CR to the extent that performance by the ninth extinction trial showed a 73% decrement from mean asymptote. Over the same interval, partially reinforced groups demonstrated only a 27% response decrement. (If the performance of group OM-P-50 was excluded, the mean response decrement was only 24% in the first nine trials.) However, extinction within the partial reinforcement groups was differential with respect to the other experimental factors.

The performance of group OM-P-50 showed little variation from the asymptote of acquisition. It is likely that the main effect of Masking Procedure was due, for the most part, to this group. Since group OM-P-50 failed to attain a performance level normally associated with conditioning, comparing the extinction performance between

OM-50 conditions appeared vacuous. While the PRE was apparent in conditions OM-150, the extinction rates of reinforcement groups in condition MM-150 were highly similar. An apparent PRE was noted for the reinforcement conditions within MM-50, however. An analysis of the linear and quadratic trends, presented in Table VI, more completely describes these data.

Significance of the $R \times T$ linear and quadratic trends was evidence of the difference in slope and curvature of extinction curves between reinforcement groups. The overall effects of Masking Procedure and UCS Intensity failed to produce differences in the slopes of curves. Extinction rates for continuous reinforcement groups in either the OM or MM procedures were nearly identical. The slopes of extinction for partial reinforcement groups under the OM procedure differed little as the function of UCS intensity. However, the comparison between linear trends for groups MM-P-50 and MM-P-150 demonstrated a significantly steeper slope for the higher UCS intensity; $F(1, 1216) = 6.16, p < .05$. This differential effect of UCS intensity was noted in the near significant $M \times R \times I \times T$ interaction for linear trend. Compared on quadratic components of trend, this interaction proved significant and was evidence of the apparent lack of PRE for the MM-150 condition. Specific comparisons of trend

Table VI

Analysis of variance for linear and quadratic components of trials and trial interactions over extinction

Source	MSQ	df	F
<u>Linear Components:</u>			
Trials (T)	38.316	1	88.08**
Masking Procedure x T	.547	1	1.26
Reinforcement Schedule x T	9.355	1	21.51**
UCS Intensity x T	.898	1	2.06
M x R x T	.505	1	1.16
M x I x T	.015	1	
R x I x T	1.434	1	3.30
M x R x I x T	1.569	1	3.61
<u>Quadratic Components:</u>			
T	7.786	1	17.90**
M x T	.001	1	
R x T	16.991	1	39.06*
I x T	1.334	1	3.07
M x R x T	.012	1	
M x I x T	.002	1	
R x I x T	.354	1	
M x R x I x T	2.852	1	6.56*
Residual	.435	1216	

* $\underline{p(F)} < .05$

** $\underline{p(F)} < .01$

components between groups MM-C-150 and MM-P-150 substantiated the lack of PRE; $F < 1.0$ for both linear and quadratic components.

Asymptotic performance during acquisition for the partial reinforcement group was substantially lower than that of continuously reinforced SS. If there are response decrements as the result of experimental extinction, comparisons of main effects across trials tend to be biased for groups with lower acquisition scores. Owing to the lower bound of the response measure, comparisons of the slope of extinction curves are biased toward groups exhibiting the greater proportion of CRs at the end of acquisition. In conditions where asymptotic performance differs, Anderson (1963) has proposed several methods to measure the rates of extinction which are assumed to avoid such biases.

The measure $\bar{f}(n)$ has been applied in several studies (Spence, Rutledge and Talbot, 1964; Spence, 1966b; Spence and Platt, 1967) for the analysis of extinction data where groups have evidenced differential acquisition performance or arbitrary slope functions are required. Formed as a mean over n trials, this statistic is indicative of a group's resistance to extinction and is expressed as the proportion

$$f(i) = \frac{(R_{\infty} - R_i)}{(R_{\infty} - R_0)}$$

where $\underline{R}_\infty$ is some assumed asymptotic performance level following extinction, $\underline{R}_0$ the performance of an $\underline{S}$ at the end of acquisition, and $\underline{R}_i$ his performance on the i^{th} extinction trial or trial block. The greater the value of $\bar{f}(n)$, the more resistant an $\underline{S}$ is to extinction; e.g., the less his average adjusted performance decrement over the extinction trials. "The function is completely arbitrary, subject to the restrictions that $f(0) = 1.0$ and $f(\infty) = 0.0$. These boundary conditions serve to reduce $\bar{f}(n)$ to a standard form which is defined as the shape of the [extinction] curve [Anderson, 1963, p. 165]."

For the purposes of analysis mean shape functions were calculated over the first 15 and all 30 extinction trials; $\underline{R}_\infty$ assumed to be 0.10 for all groups. Group means are presented in Figure 5. For both the $\bar{f}(15)$ and $\bar{f}(30)$ measures, continuously reinforced groups showed less resistance to extinction than did partially reinforced $\underline{S}$ s. Curves for the partial reinforcement groups deserve some explanation, however.

Examination of $\underline{S}$ s' records from group OM-P-50 showed that 60% of the $\underline{S}$ s evidenced a terminal acquisition level which was equal to or less than $\underline{R}_\infty$. If $\underline{R}_0$ is less than $\underline{R}_\infty$, random fluctuations about asymptotic extinction tend to produce an $\bar{f}(n)$ indicative of no resistance to extinction; i.e., close to zero. When $\underline{R}_0$ is equal to $\underline{R}_\infty$, the

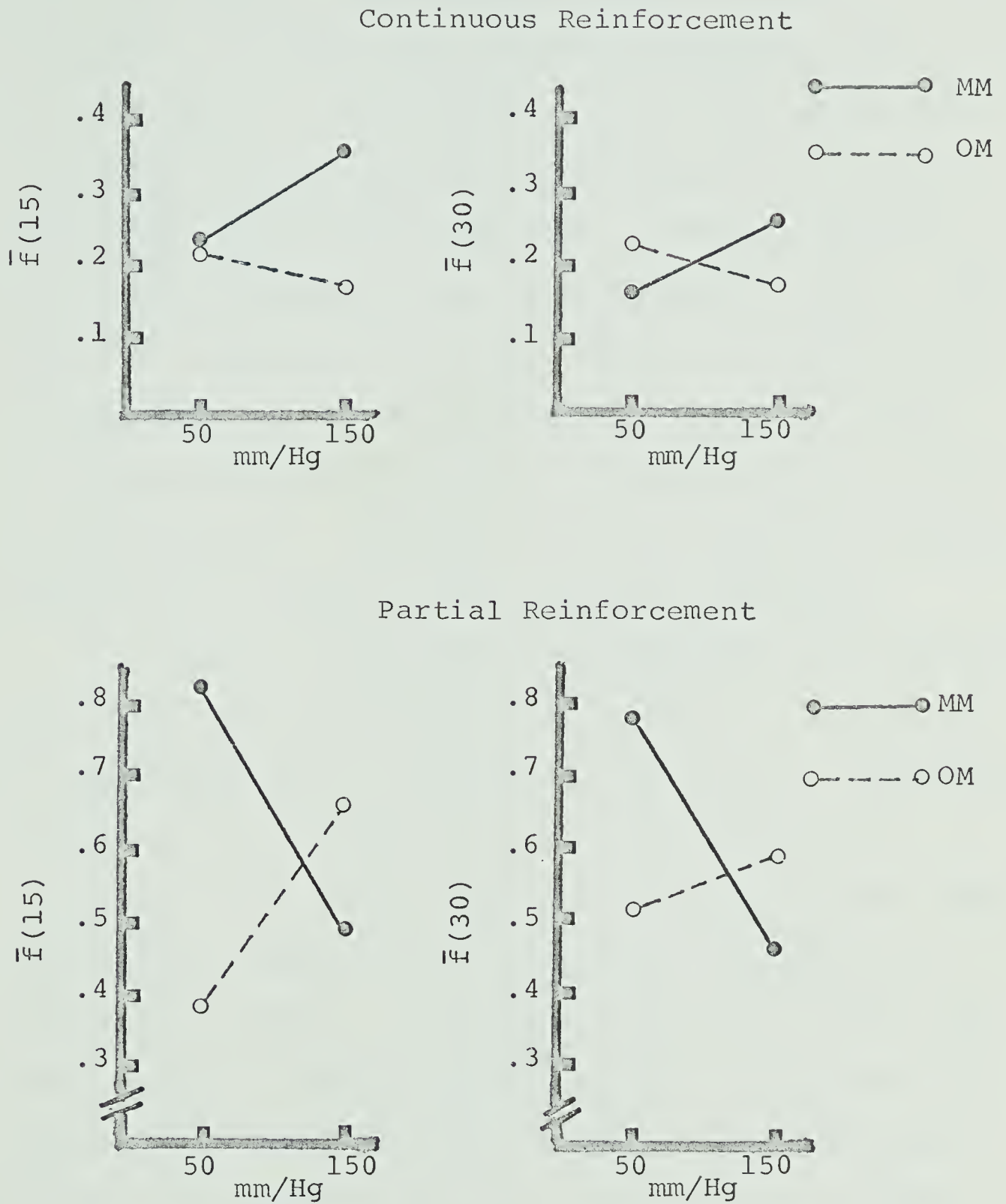


Figure 5: Mean shape function indices [$\bar{F}(n)$] of extinction curves for reinforcement groups under 50- and 150-mm/Hg UCS intensities. The upper panels present statistics for continuously reinforced Ss under modified masking (MM) and original masking (OM) procedures based on the first 15 and all 30 extinction trials. The lower panels present the same statistics for partially reinforced Ss.

denominator of the equation goes to zero and some convention for the substitution of $\bar{f}(n)$ values is necessary. In both these cases the statistic was set zero for all trial blocks. This value would be indicative of no resistance to extinction and seemed reasonable since these ss failed to exceed asymptotic extinction performance over 90 acquisition trials. However, it is apparent that when acquisition performance is extremely low the shape function measure is unable to provide adequate adjustment for comparison of extinction performance. Moreover, it is not apparent that any statistic is capable of the necessary adjustment.

An analysis of variance was performed upon both the $\bar{f}(15)$ and $\bar{f}(30)$ measures for all groups. The results of that analysis are presented in Table VII. While the steeper slope of extinction for group MM-P-150 is reflected in the lower value of the shape function index, the analysis showed only Reinforcement Schedule as a significant effect. The marked drop in the $\bar{f}(15)$ and $\bar{f}(30)$ measures between conditions MM-P-50 and MM-P-150 again demonstrates the lack of PRE in this condition. The near significant ($.05 < p < .10$) $M \times R \times I$ interaction is the result of the differential $\bar{f}(15)$ measures for the partial reinforcement groups over the levels of UCS intensity. Compared to these differences, the shape

Table VII

Summary of analysis of variance of shape function
index [f(n)] averaged over 15 and 30
extinction trials

Averaged over 15 trials				
Source	SSQ	df	MSQ	F
Masking Pro- cedure (M)	.517	1	.517	1.21
Reinforcement Schedule (R)	4.738	1	4.738	11.10*
UCS Inten- sity (I)	.0001	1	.0001	
M x R	.019	1	.019	
M x I	.422	1	.422	
R x I	.039	1	.039	
M x R x I	1.503	1	1.503	3.52
S (MRI)	64.882	152	.427	
Averaged over 30 trials				
Source	SSQ	df	MSQ	F
M	.047	1	.047	
R	5.643	1	5.643	15.36*
I	.115	1	.115	
M x R	.036	1	.036	
M x I	.150	1	.150	
R x I	.194	1	.194	
M x R x I	.772	1	.772	2.10
S (MRI)	55.841	152	.367	

* $\underline{p(F)} < .01$

function indices for continuous reinforcement groups show little effect of UCS intensity.

In summary, the analysis of extinction data demonstrated the existence of a PRE under both masking procedures. The extinction of continuously reinforced Ss was unaffected by the intensity of the UCS or masking procedure employed. Groups OM-P-150 and MM-P-50 showed extinction rates significantly slower than those of their continuously reinforced counterparts. An absence of the PRE was noted in the case of groups within the MM-150 condition where the rate of extinction between partial and continuous groups did not differ significantly. There was some question as to the "extinction" of group OM-P-50 whose performance showed little conditioning after 90 acquisition trials.

Probability Learning

Predictions during the PL trials were recorded in terms of the frequency with which Ss predicted E_1 (the most frequently occurring of the two RLs) in blocks of 10 trials. Because data showed less evidence of random variation, proportions of A_1 responses (E_1 predictions) were formed over blocks of 20 trials and are presented in Figure 6. While markedly similar in many respects, there are significant effects which make these curves different from those obtained under the usual binary

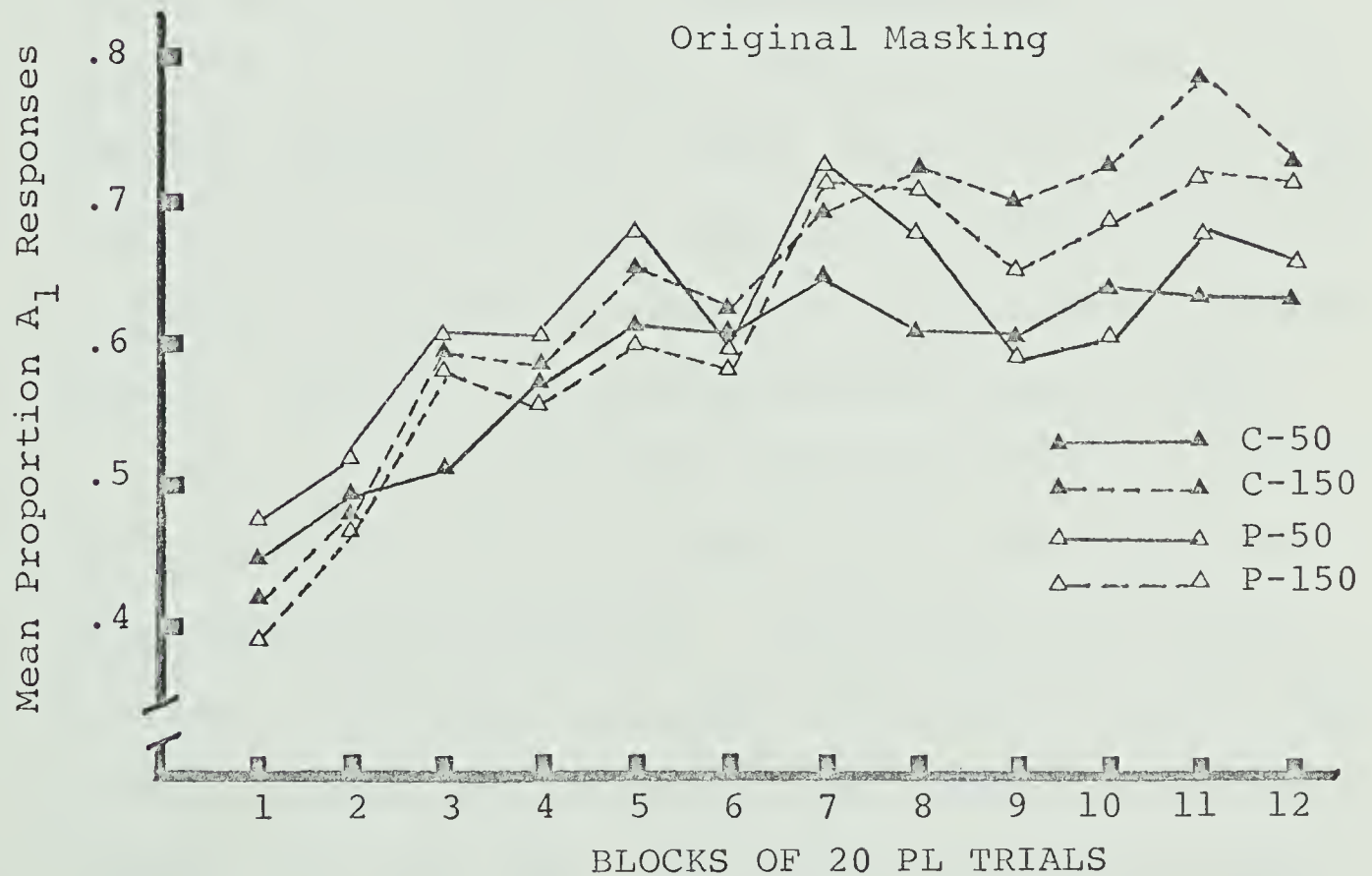
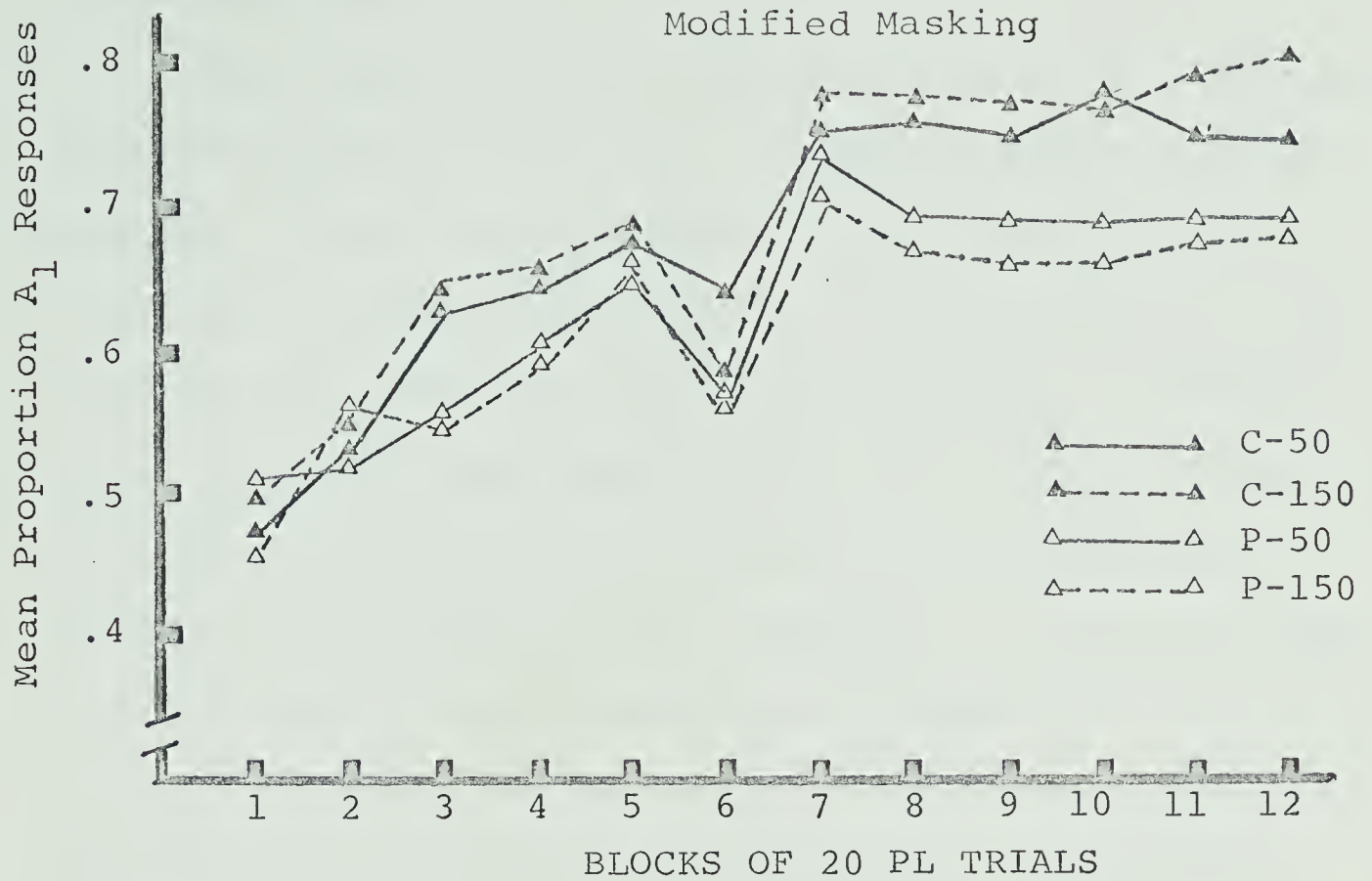


Figure 6: Mean proportion A_1 responses (E_1 predictions) under schedules of continuous and partial reinforcement and 50- and 150-mm/Hg UCS intensity during conditioning.

prediction task.

Most exceptional was the depression in A_1 responses between trials 101 and 120. Although present in both masking procedures, this effect is more noticeable in the data from the MM conditions. There is little evidence of such findings in previous research. However, Anderson (1960) has reported that the number of times E_1 and E_2 alternate over successive trials significantly affects the frequency of A_1 responses. As event alternations increase the conditional probabilities [$\underline{p}(E_1|E_1)$] and [$\underline{p}(E_2|E_2)$] of the two events become more equal and the frequency with which $\underline{S}$ s respond A_1 on successive trials tends to reduce. These predictions have been supported in several studies (Beach and Swensson, 1967; Gambino and Myers, 1967; Myers, Butler and Olson, 1969), although discussions have been of the effects of successive event occurrences rather than conditional probabilities. However, the same conclusions may be drawn.

First order conditional probabilities for events E_1 - E_1 were calculated for each trial block using the programmed event sequences. While $\underline{p}(E_1|E_1)$ remained constant (.571) over all other trial blocks, during the critical period between trials 101 - 140 it fluctuated between .538 and .600. The lowest conditional probability coincided with the point of greatest depression

in the response curves. Product-moment correlations between the proportion A_1 responses in each group and conditional $p(E_1|E_1)$ were calculated over the 12 trial blocks. The fact that all correlations proved significant ($p < .05$) seemed to offer tentative support for the assumption that the response depression was a function of the trial programming of successive events. In addition, it appeared that conclusions that $\underline{S}$ s tend to respond to the event sequence rather than event frequency were justified (Anderson, 1960; Gambino and Myers, 1967). It is interesting to note that, although $\underline{S}$ s are apparently sensitive to the changes of event sequences in the PL task, there was no evidence of any consistent effect following the change from acquisition to extinction in the conditioning procedure.

In view of the effect of trial programming upon predictions, an analysis of variance was performed upon the mean proportion A_1 responses over the last 80 PL trials. Results of the analysis are presented in Table VIII. $\underline{S}$ s in the MM condition showed greater frequency of A_1 responses than did those within the OM procedure. When the UCS intensity was 150-mm/Hg in the OM procedure, $\underline{S}$ s more frequently predicted E_1 than when the 50-mm/Hg intensity was employed. However, the effect of Masking Procedure and UCS intensity was differential as evidenced

Table VIII

Summary of analysis of variance of proportion
A₁ responses over the last 80 PL trials

Source	SSQ	df	MSQ	F
Masking Procedure (M)	.125	1	.125	6.16*
Reinforcement Schedule (R)	.111	1	.111	5.49*
UCS Intensity (I)	.083	1	.083	4.09*
M x R	.052	1	.052	2.58
M x I	.066	1	.066	3.25
R x I	.024	1	.024	1.19
M x R x I	.0001	1	.0001	
S (MRI)	3.069	152	.020	

* $\underline{p}(\underline{F}) < .05$

by the near significant $M \times I$ interaction. There was only a slight increase in A_1 responses as a function of increasing UCS intensity in the MM procedure but partially reinforced $\underline{S}$ s tended to predict E_1 less frequently in this condition. The effects of UCS intensity upon A_1 predictions were not found in a previous study (Bernstein and Rutledge, 1969) involving continuous reinforcement in the cognitive masking situation.

Estes and Straughan (1954) reported that asymptotic performance in the binary prediction task most closely approximated the marginal probability of E_1 . Thus, while it is interesting to note performance differences in themselves, a more lucid comparison may be to examine the predicted and recorded A_1 responses. To this end a set of post hoc comparisons was calculated to consider these relationships. As suggested by Davis (1969), the residual mean square from the analysis of variance and a two-tailed alpha level of .003 were employed.

Results of the comparisons showed significantly different proportion A_1 responses than predicted for groups MM-C-50 [$\underline{t}(152) = 2.91$], MM-C-150 [$\underline{t}(152) = 4.30$], OM-C-50 [$\underline{t}(152) = 3.71$] and OM-P-50 [$\underline{t}(152) = 3.25$]. The remaining comparisons failed to reach significance, even at the .05 level. $\underline{S}$ s within the MM-C condition tended to emit more A_1 responses than predicted, while those in the OM-50

conditions predicted E_1 less frequently than expected. This suggests some effect of the conditioning procedures upon the response tactic of Ss.

Beach and Swennson (1967) have suggested that selection of a particular response strategy is dependent upon the ability of Ss to isolate relevant information of the event sequences. It may be argued that the events occurring on conditioning trials have differential effects upon PL performance as a function of the trial programming between masking procedures. However, the present data are not sufficiently detailed to fully consider the nature of these effects. The character of trial-to-trial responses would be necessary to elaborate the effects of experimental conditions. The data are interesting in that they describe, roughly, the effects of conditioning parameters upon binary predictions in the two masking procedures. Without further and more detailed data it is impossible to describe exactly what these effects are, however. The presence of the differential performances is somewhat of a contradiction to previous research (Bernstein and Rutledge, 1969), but the source of the effects remains hypothetical.

DISCUSSION

The major results of this experiment may be summarized as follows:

- (1) A significant effect of the schedule of reinforcement upon acquisition performance in both masking conditions;
- (2) Significant effects of UCS intensity within the OM but not within the MM procedure; and
- (3) Significant PREs for conditions OM-150 and MM-50 but no effect of reinforcement schedule upon rates of extinction for groups within the MM-150 condition.

For the sake of simplicity, discussion will deal with the results of acquisition followed by analyses of extinction performance.

A schedule of partial reinforcement led to a significant performance decrement during acquisition in all conditions of the present study. These results are consistent with evidence from a variety of experiments (Hull, 1943; Spence, 1956; Lewis, 1960; and Kimble, 1961), but contradict the findings of Spence and Platt (1967). The latter study evidenced nearly identical acquisition performance between conditions of continuous and partial reinforcement; a finding which is not

amenable to interpretation by either classical behavior or expectancy-type theories. Although both continuous and partial reinforced groups received the same number of reinforced trials, performance decrements with the partial reinforcement schedule would still be expected as the result of increased inhibition resulting from successive nonreinforcements.

The partial reinforcement schedule employed by Spence and Platt differed from that within the OM procedure of the present study with respect to the events occurring on nonreinforced trials. While a delayed UCS was employed in their study, omission of the UCS on nonreinforced trials was employed in the present experiment. Reynolds (1958) concluded that the delayed UCS presentations serve only to maintain D under schedules of partial reinforcement. However, Spence and Platt (1967) argued that the procedure also failed to provide nonreinforcement in the cognitive masking situation in the same sense it did within standard conditioning procedures. However, they did not attempt to explain why this should be the case.

The partial reinforcement decrement obtained here strongly suggests that the delayed UCS procedure is responsible for Spence and Platt's results. Within the framework of classical behavior theory, the current findings may be interpreted as the consequence of both lower levels of

$\underline{D}$ and greater $\underline{I}_n$ resulting from the differential frequency of UCS presentations between reinforcement groups. It is also possible that Spence and Platt's findings are the result of equal habit strengths between groups. In addition to maintaining the level of general arousal, delayed UCS presentations in the cognitive masking situation may provide a stimulus contingency sufficient for reinforcement of the CR. However, the question of whether a delayed UCS leads to maintenance of $\underline{D}$, increments in $\underline{H}$, or retardation of the development of $\underline{I}_n$ in the cognitive masking situation cannot be answered from the previous results.

Equating reinforcement groups for the number of reinforced trials showed that continuously reinforced $\underline{Ss}$ continued to emit more CRs than those receiving a schedule of partial reinforcement. This fact would prove to be an empirical complication for the formulations advanced by Hull (1943), since the theory offers no formal propositions relating the effects of nonreinforcement to acquisition performance. It may be assumed, however, that responses emitted in the absence of the UCS lead neither to increments nor decrements of $\underline{H}$. Thus, if the frequency of reinforcement is equated between groups, equal levels of $\underline{H}$ are assumed and performance decrements resulting from partial reinforcement unexpected.

It might be argued that the effects of $\underline{I_r}$ should be greater for partial reinforcement groups since, in order to equate the frequency of reinforcement, they participate in more conditioning trials than continuously reinforced $\underline{Ss}$. However, within the Hullian model, $\underline{I_r}$ results from responses to the CS. Hence, to attribute lower responding rates to reactive inhibition would necessitate partially reinforced $\underline{Ss}$ demonstrating a response frequency at least equivalent to their continuously reinforced counterparts. Original propositions related $\underline{sI_r}$ to stimuli associated with cessation of a response and the effort involved in responding within instrumental reward situations. Considering the "experimenter operations" and "task demands" (Prokasy, 1965) of the classical conditioning paradigm, it is unclear to what extent effects of $\underline{sI_r}$ may contribute to the partial reinforcement decrement.

Spence (1956, 1958) proposed that nonreinforcement produced decrements in $\underline{E}$ resulting from the failure to provide the necessary contingency between the CS and UCS. Rather than affecting $\underline{H}$, nonreinforcement was assumed to lead to increments in $\underline{I_n}$ and decrements in $\underline{D}$ associated with fewer presentations of the UCS. Thus, partially reinforced $\underline{Ss}$ are expected to perform at a lower rate consistent with the differential effects of

$\underline{I}_n$ and $\underline{D}$. A partial reinforcement decrement based on equated trials is also predicted within the formulations of expectancy theory. According to these propositions, response acquisition depends not upon the frequency but the probability of reinforcement. Since a procedure equating the frequency of reinforcement still fails to alter the probability of UCS, the theory predicts lower response probability associated with partial reinforcement.

Spence's propositions of stimulus contingency are strikingly similar to those of expectancy-type theories (Tolman, 1959; Prokasy, 1965; and Rescorla, 1967); a point which Spence (1960) stressed, yet has not met wholehearted acceptance. It may, in fact, be the effects of $\underline{I}_n$ or $\underline{D}$ which account for the partial reinforcement decrement in the present study. However, one can hardly ignore the economy offered by expectancy theory.

Failure to find significance of the M x R interaction in analyses of acquisition data appears to indicate that the effects of nonreinforcement are not influenced by differences in the contingency between PL and conditioning trials. A previous study (Ross, Wilcox and Mayer, 1967) suggested that temporally compounding events within the conditioning trials, as in the OM

procedure, may produce effects in response acquisition. This does not appear to be the case, at least when non-reinforcement involves omission of the UCS. It is likely that omission of the UCS avoids many of the effects of stimulus compounding in the OM procedure. However, this conclusion rests on the assumption that PL and conditioning trials are subjectively discrete events under the MM procedure.

In an earlier section it was argued that the SL component of the OM procedure may serve as a type of ready signal for CS presentations. Such a position appears reasonable in light of the fact that the CS follows the SL, at a fixed interval, with a probability of .50 within this procedure. Frequencies of short-latency responses failed to demonstrate reliable differences as a function of the masking procedure employed. However, results suggest that inhibition of the CR occurs if SL and CS are temporally contingent events.

Some indication of response inhibition is evident in the comparison of groups OM-P-50 and MM-P-50. Following 45 reinforced presentations of the CS, group OM-P-50 showed little evidence of conditioning and emitted 35% fewer CRs than the comparable group under the MM procedure. Yet, performance of OM-P-150 and the two MM-P groups were nearly identical. This appears to imply that

50-mm/Hg is below the requisite threshold to evidence conditioning under the OM procedure, but exceeds the necessary intensity threshold in the MM procedure. Thus, effects of the UCS seem to be mediated by the predictability of conditioning trials as well as the effects of the CS-UCS contingency (cf. Foth, 1968). The source of this effect is as yet unknown, although use of the ready signal (or, SL in the OM procedure) may allow for incorporation of inhibitory response sets as suggested by Kimble (1967). Moreover, predictability of the occurrence of a conditioning trial may represent one of the "experimenter operations" (Prokasy, 1965) influencing acquisition and shaping the CR.

Asymptotic performance of both the MM-C conditions and group OM-C-150 was consistent with the majority of previous research involving the masking procedure, although the acquisition period was extended to 90 trials. In addition, performance coincided with the high intensity group from the Bernstein and Rutledge (1969) study after 90 acquisition trials. Several previous studies involving the masking procedure (Goldstein, 1962; Spence, Homzie and Rutledge, 1964; Berman, Williams and Schneiderman, 1967; and Spence and Platt, 1967) have reported asymptotic proportion of CRs for continuously reinforced SS which never exceeded 65%.

These levels were markedly lower than those reported for Ss conditioned in the absence of cognitive masking within the same experiment (Spence, 1963; and Spence, Homzie and Rutledge, 1964). Although exceptions to these results have been reported, they have either eliminated Ss as nonconditioners (Spence, 1966a), or extended the acquisition period to several hundred trials (Bernstein and Rutledge, 1969).

One possible explanation of this lower acquisition performance may rest with the joint conditioning tasks employed in the masking procedure; that is, participation in the two tasks may produce a much lower performance ceiling than that of standard conditioning procedures. Ss, faced with the "task demands" (Prokasy, 1965) of the situation, may sacrifice efficiency in the performance of one to gain sufficiency in the performance of both tasks. Although this must remain conjecture at the moment, it leads to a possible explanation of the effects of UCS intensity upon continuously reinforced Ss.

If the SL within the OM procedure serves as a ready signal, CRs may be inhibited to the extent that the stronger UCS intensity is required to produce maximal performance. However, under the MM procedure, in the absence of the SL-ready-signal, 50-mm/Hg may be sufficient to produce the maximum frequency of CRs. Therefore,

elevating the UCS intensity to 150-mm/Hg in this condition would have no further effect upon performance. Such an interpretation seems warranted in light of the fact that performance between continuously reinforced groups at the higher intensity was nearly identical.

The effect of UCS intensity in the OM-C condition was similar to that reported in previous research (Spence and Platt, 1966; and Bernstein and Rutledge, 1969) and consistent with effects in standard conditioning procedures. However, the MM-C groups showed no difference in performance as a function of UCS intensity. On the basis of previous research, it appears that values in the neighborhood of 65% CRs approximate a performance ceiling under the cognitive masking situation. Without incorporating the limiting performance bound, usual predictions call for parallel but separate acquisition slopes across the levels of UCS intensity.

There are certainly levels of UCS intensity which are insufficient to produce evidence of conditioning under schedules of continuous reinforcement. However, the classical contingency may be such as to allow for the influence of instrumental factors at much lower levels than in cases of partial reinforcement. Factors such as the presence of a ready signal or joint conditioning

tasks may affect the intensity limen as well as the performance ceiling. To fully justify these assumptions requires the examination of results from more than two UCS intensities in the cognitive masking procedure.

Only a slight reduction in the proportion of CRs was noted for group OM-P-50 over the 30 extinction trials. In general, their performance differed little from that during the acquisition period. If this group is assumed to have evidenced little or no conditioning, it appears somewhat capricious to expect any evidence of extinction. Although Masking Procedure emerged as a significant effect over extinction trials, it is probable that the analysis was greatly affected by the performance of this one group. Therefore, they are perhaps better excluded from consideration of the results of extinction.

Significant differences in the rates of extinction were noted between reinforcement schedules of groups OM-150 and MM-50. More dramatic, however, is the similarity in rates of extinction evidenced by continuously reinforced Ss. Neither UCS intensity nor Masking Procedure proved significant influences on the rates of extinction of these groups. In addition, their rapid extinction provides grounds for questioning the validity of Spence's propositions regarding the control of cognitive inhibitory factors.

According to Spence's discrimination hypothesis, the rate of extinction evidenced by continuously reinforced Ss suggests that the OM procedure was ineffective in controlling higher-order response sets. Yet, this condition nearly replicated procedures eliminating PREs in earlier experiments. The factor distinguishing the OM from previous procedures was the exclusion of the UCS during extinction. Results within standard conditioning procedures (McAllister, 1953; Reynolds, 1958; Spence, 1963; and Spence, Homzie and Rutledge, 1964) have shown that retardation of the rate of extinction may be accomplished by lengthening the CS-UCS ISI. However, whether paired or explicitly independent of the CS, UCS presentations were assumed to operate independent of cognitive factors solely upon the maintenance of D.

Incorporating a delayed UCS in the context of the masking procedure proved to be inappropriate (Goldstein, 1962), as it tended to provide reinforcement for the maintenance of CRs during the extinction period. The alternative procedure of explicitly unpaired UCS presentations was assumed (Spence and Platt, 1967) to eliminate aspects of reinforcement. However, present results appear to cast doubt on the appropriateness of this suggestion as well.

Extinction in the present experiment involved omission

of the UCS. Spence (1966a) suggested that, following continuous reinforcement in the cognitive masking situation, this procedure rapidly extinguished CRs as the result of the reduction of drive rather than I_n build up. Drive reduction may account for the current results. However, it seems that drive reduction should be greater and extinction more rapid for groups receiving the greater UCS intensity. Such a prediction is not supported within the present experiment.

The effect of UCS intensity was noted within the MM procedure. Results of extinction within the MM-150 were similar to those reported by Goldstein (1962) for a UCS-omitted condition. Spence (1966b) interpreted the lack of PRE in that study to again be the result of drive reduction. However, to apply that prediction to the present data would assume similar rates of extinction for both the MM-150 and OM-150 conditions. The fact that the OM-150 groups show significant PREs tends to reduce the generality of an interpretation based on reduction of drive. In addition, since Spence and Platt (1967) maintained the UCS in extinction, reduction of $\underline{D}$ would not be sufficient to explain their results.

Yet, when compared with the Spence and Platt data, current results indicate that absence of the UCS during extinction clearly affects rates of extinction. In part-

icular, the use of CS-alone trials led to rapid extinction following continuous reinforcement even though conditioning was conducted in the context of the cognitive masking procedure. At this point, it appears worthwhile to explore possible effects of UCS presentations during extinction under this procedure.

Under the OM procedure onset of the CS was made contiguous with the turning off of SL as in previous experiments. It has been argued that SL may serve the function of a ready signal during acquisition. When extinction involves presentations of the UCS, the SL may retain its signal properties as the result of the continued contiguity of the events. In addition, the SL-CS complex may acquire functional properties of a serial CS (Williams, 1965) or compound CS. During extinction in the presence of the UCS, the procedure may be conceived as a test of components of the stimulus compound. Both Wickens (1965) and Razran (1965) have reported research demonstrating retained effectiveness of the stimulus complex in the presence of component reinforcement. This apparently is the result of the first component (SL) acquiring the capacity to evoke "sensory effects" (Wickens, 1959) of the latter. Hence, reinforcing the initial component by presentation of the UCS may serve to maintain effectiveness of the complex

throughout extinction. In addition, results from Dufort and Kimble (1958) suggest that, during interpolated UCS-alone trials, a ready signal may acquire properties of a CS although the ISI is not particularly favorable.

Extinction rates within the OM procedure imply that any signal properties acquired by the SL during acquisition are lost quickly during extinction in the absence of UCS. It appears unlikely that the SL-CS complex or particular components retain UCS-signal properties when extinction involves CS-alone trials. It is more likely that nonreinforcement, either through response inhibition or the development of counterexpectancies, successively weakens secondary sensory effects of the SL so that neither it nor the CS elicit the CR. Previous results (Berman, Williams and Schneiderman, 1967) suggest that while the SL gains "CS" properties during acquisition, they are lost as rapidly as the signal properties of the formal CS during extinction. Although extinction in the present study was more rapid than that reported by these authors, account should be taken of procedural differences between experiments. Infraorbital shock may be sufficiently motivating to produce the gradual decline in CR frequency reported in their study. However, absence of the air puff may have quite different functional properties since the CR results in a modification of the

effect of the UCS.

Within the MM procedure, it is unlikely that the SL becomes a component of the effective CS. It is more likely that SL serves as a signal of a "UCS-safe" period as the result of the temporal arrangement of PL and conditioning trials. The similarity of extinction rates between continuous reinforcement conditions of the MM and OM procedures further supports the proposition that signal properties of the SL-CS complex acquired during acquisition are lost quickly during extinction. In addition, it appears that any secondary sensory effects of the SL acquired in acquisition are eliminated as rapidly as effects acquired by the CS alone. The need for further research specifically directed to these contentions is apparent.

One additional aspect of the data warrants consideration. While UCS intensity had no effect upon rates of extinction following continuous reinforcement, it proved significant in the case of the MM-P condition. Note has been made previously of the fact that a drive reduction interpretation (Spence, 1966b), if applied these data, cannot be generalized to the OM condition. An alternative interpretation rests in the propositions of expectancy theory. It will be recalled that the PRE is explained in terms of the degree of difficulty assoc-

iated with the establishment of the expectancy of uniform nonreinforcement. Following continuous reinforcement, the shift to extinction involves such a change in procedure that it is probably readily recognizable regardless of UCS intensity. It is within the bounds of expectancy theory to predict a more rapid extinction under strong UCS intensities due to the fact that expectancies of reinforcement are more likely to be disconfirmed within a few trials in the absence of the UCS. Such an assumption rests on the proposition that, for Ss receiving a schedule of partial reinforcement, absence of the stronger UCS intensity is more readily recognizable.

If this proposition is to be generalized, however, the theory must also predict similarity in the rates of extinction for reinforcement groups within the OM-150 condition. Results demonstrating a significant PRE under this procedure failed to confirm this prediction. Thus, neither a reduction-of-drive nor expectancy theory can adequately account for the differential effects of UCS intensity following schedules of partial reinforcement.

On the basis of current results an adequate argument may be advanced that a critical factor affecting rates of extinction in previous cognitive masking procedures has been presence of the UCS. The precise nature of the effects cannot be known without further research examining

the conditionable properties of the SL-CS complex within procedures involving presentation of the UCS. It seems apparent, however, that the central proposition behind the incorporation of the masking procedure cannot be accepted until effects of the UCS are examined. It appears too early to accept or reject the assumption that the addition of a secondary task serves only to eliminate cognitive involvement in the process of simple conditioning and extinction.

REFERENCES

- Adams, J.K. Laboratory studies of behavior without awareness. Psychological Bulletin, 1957, 54, 383-405.
- Anderson, N.H. Effect of first-order conditional probability in a two-choice learning situation. Journal of Experimental Psychology, 1960, 59, 73-93.
- Anderson, N.H. Comparison of different populations: Resistance to extinction and transfer. Psychological Review, 1963, 70, 162-179.
- Beach, L.R., and Swensson, R.G. Instructions about randomness and run dependency in two-choice learning. Journal of Experimental Psychology, 1967, 75, 279-282.
- Beecroft, R.S. Classical conditioning. Goleta: Psychonomic Press, 1966.
- Berman, J., Williams, C.D., and Schneiderman, N. Warning signal as a component of a compound stimulus in human eyelid conditioning. Psychonomic Science, 1967, 9, 541-542.
- Bernstein, A.L., and Rutledge, E.F. Simultaneous performance in eyelid conditioning and probability learning as a function of puff intensity. Journal of Experimental Psychology, 1969, 79, 22-26.

- Boice, R., and Boice, C. An inverse effect of UCS intensity upon partially reinforced eyelid conditioning. Psychonomic Science, 1966, 5, 69-70.
- Davis, D.J. Flexibility and power in comparisons among means. Psychological Bulletin, 1969, 71, 441-444.
- Dufort, R.H., and Kimble, G.A. Ready signals and the effects of interpolated UCS presentations in eyelid conditioning. Journal of Experimental Psychology, 1958, 56, 1-7.
- Estes, W.K., and Straughan, J.H. Analysis of verbal conditioning situation in terms of statistical learning theory. Journal of Experimental Psychology, 1954, 47, 225-234.
- Foth, D.L. Effects of unconditioned stimulus intensity and schedule of partial reinforcement in human eyelid conditioning. Unpublished Masters Thesis, University of Alberta, 1958.
- Foth, D.L., and Runquist, W.N. Effects of unconditioned stimulus intensity and schedules of 50% reinforcement in human eyelid conditioning. Journal of Experimental Psychology, 1970, 84, 244-247.
- Gambino, B., and Meyers, J.L. Role of event runs in probability learning. Psychological Review, 1967, 74, 410-419.

- Goldstein, H. The effects of set factors and reinforcement schedules in acquisition and extinction of the conditioned eyelid response. Unpublished doctoral dissertation, University of Iowa, 1962.
- Goodrich, K.P. Effect of ready signal on the latency of voluntary responses in eyelid conditioning. Journal of Experimental Psychology, 1964, 67, 496-498.
- Greenhouse, S.W., and Geisser, S. On methods of analysis of profile data. Psychometrika, 1954, 29, 95-112.
- Grings, W.W. Verbal-perceptual factors in conditioning of autonomic responses. In W.F. Prokasy (Ed.), Classical conditioning: A symposium. New York: Appleton-Century-Crofts, 1965.
- Hebb, D.O. The American revolution. American Psychologist, 1960, 735-745.
- Hull, C.L. Principles of behavior. New York: Appleton-Century-Crofts, 1943.
- Humphreys, L.G. The effect of random alternation of reinforcement on acquisition and extinction of conditioned eyelid responses. Journal of Experimental Psychology, 1939a, 25, 141-158.
- Humphreys, L.G. Acquisition and extinction of verbal expectations in a situation analogous to conditioning. Journal of Experimental Psychology, 1939b, 25, 294-301.

- Kimble, G.A. Hilgard and Marquis' conditioning and learning (2nd ed.). New York: Appleton-Century-Crofts, 1961.
- Kimble, G.A. Attitudinal factors in eyelid conditioning. In G.A. Kimble (Ed.), Foundations of conditioning and learning. New York: Appleton-Century-Crofts, 1967.
- Lewis, D.J. Partial reinforcement since 1950: A selective review of the literature. Psychological Bulletin, 1960, 57, 1-18.
- McAllister, W.R. The effect on eyelid conditioning of shifting the CS-UCS interval. Journal of Experimental Psychology, 1953, 45, 423-428.
- Meyers, J.L., Butler, Patricia, and Olson, Diane. Run lengths and probabilities in binary prediction. Journal of Mathematical Psychology, 1969, 6, 444-455.
- Mowrer, O.H., and Jones, Helen, M. Habit strength as a function of the pattern of reinforcement. Journal of Experimental Psychology, 1945, 35, 293-311.
- Norris, Eugena, B., and Grant, D.A. Eyelid conditioning as affected by verbally induced inhibitory set and counterreinforcement. American Journal of Psychology, 1948, 61, 37-49.
- Postman, L. Rewards and punishment in human learning. In L. Postman (Ed.), Psychology in the making.

New York: Alfred A. Knopf, 1962.

Price, L.B., Abbot, D.W., and Vandament, W.E. Effects of CS and UCS change upon extinction of conditioned eyelid response. Journal of Experimental Psychology, 1965, 69, 437-438.

Prokasy, W.F. Classical conditioning: Experimenter operations, task demands, and response shaping. In W.F. Prokasy (Ed.), Classical conditioning: A symposium. New York: Appleton-Century-Crofts, 1965.

Prokasy, W.F., Carlton, R.A., and Higgins, J.D. Effects of nonrandom intermittent reinforcement schedules in human eyelid conditioning. Journal of Experimental Psychology, 1967, 74, 282-288.

Prokasy, W.F., Grant, D.A., and Meyers, N.A. Eyelid conditioning as a function of unconditioned stimulus intensity and intertrial interval. Journal of Experimental Psychology, 1958, 55, 242-246.

Razran, G. Empirical codification and specific theoretical implications of compound stimulus conditioning: Perception. In W.F. Prokasy (Ed.), Classical Conditioning: A symposium.

Rescorla, R.A. Pavlovian conditioning and its proper control procedures. Psychological Review, 1967, 74, 71-80.

Rescorla, R.A. Pavlovian conditioned inhibition.

Psychological Bulletin, 1969, 72, 95-107.

Reynolds, W.F. Acquisition and extinction of the conditioned eyeblink following partial or continuous reinforcement. Journal of Experimental Psychology, 1958, 55, 335-341.

Ross, L.E. The decremental effects of partial reinforcement during acquisition of the conditioned eyelid response. Journal of Experimental Psychology, 1959, 57, 74-82.

Ross, L.E., and Hunter, J.J. Habit strength parameters in eyelid conditioning as a function of UCS intensity. Psychological Record, 1959, 9, 103-107.

Ross, L.E., Koski, C.H., and Yeager, Judy. Classical conditioning of the severely retarded: Partial reinforcement effects. Psychonomic Science, 1964, 1, 253-254.

Ross, L.E., and Spence, K.W. Eyelid conditioning performance under partial reinforcement as a function of UCS intensity. Journal of Experimental Psychology, 1960, 59, 379-382.

Ross, L.E., Wilcox, Susan, and Mayer, Melaine J. A simple eyelid conditioning masking task and its effects upon differential conditioning. Psychonomic Science, 1967, 9, 333-334.

- Runquist, W.N. Performance in eyelid conditioning following changes in reinforcement schedule. Journal of Experimental Psychology, 1963, 65, 617-618.
- Spence, K.W. Learning and performance in eyelid conditioning as a function of UCS intensity. Journal of Experimental Psychology, 1953, 45, 57-63.
- Spence, K.W. Behavior theory and conditioning. New Haven: Yale University Press, 1956.
- Spence, K.W. Behavior theory and learning. New Jersey: Prentice-Hall, 1960.
- Spence, K.W. Cognitive factors in extinction of conditioned eyelid response in humans. Science, 1963, 140, 1224-1225.
- Spence, K.W. Extinction of the human eyelid CR as a function of presence or absence of the UCS during extinction. Journal of Experimental Psychology, 1966a, 71, 642-648.
- Spence, K.W. Cognitive and drive factors in the extinction of the conditioned eyeblink in human SS. Psychological Review, 1966b, 73, 445-458.
- Spence, K.W., Haggard, D.F., and Ross, L.E. UCS intensity and the associative (habit) strength of the eyelid CR. Journal of Experimental Psychology, 1958, 55, 404-411.

- Spence, K.W., Homzie, M.J., and Rutledge, E.F. Extinction of the human eyelid CR as a function of the discriminability of the change from acquisition to extinction. Journal of Experimental Psychology, 1964, 67, 545-552.
- Spence, K.W., and Platt, J.R. UCS intensity and performance in eyelid conditioning. Psychological Bulletin, 1966, 65, 1-10.
- Spence, K.W., and Platt, J.R. Effects of partial reinforcement on acquisition and extinction of the conditioned eyeblink in a masking situation. Journal of Experimental Psychology, 1967, 74, 259-263.
- Spence, K.W., Rutledge, E.F., and Talbot, J.H. Effect of the number of acquisition trials and the presence or absence of the UCS on extinction of the eyelid CR. Journal of Experimental Psychology, 1963, 66, 286-291.
- Tolman, E.C. A cognition motivation model. Psychological Review, 1952, 59, 389-400.
- Tolman, E.C. Principles of purposive behavior. In S. Koch (Ed.), (Vol. 2), Psychology: A study of a science. New York: McGraw-Hill, 1959.
- Tolman, E.C., and Brunswik, E. The organization and causal texture of the environment. Psychological Review, 1935, 42, 43-77.

Walker, E.L. Conditioning and instrumental learning.

Belmont, California: Brooks-Cole, 1967.

Wickens, D.D. Conditioning to complex stimuli. Amer-
ican Psychologist, 1959, 14, 180-188.

Wickens, D.D. Compound conditioning in humans and cats.

In W.F. Prokasy (Ed.), Classical conditioning:

A symposium. New York: Appleton-Century-Crofts,
1965.

Williams, D.R. Classical conditioning and incentive

motivation. In W.F. Prokasy (Ed.), Classical

conditioning: A symposium. New York: Appleton-
Century-Crofts, 1965.

Winer, B.J. Statistical principles in experimental

design. New York: McGraw-Hill, 1961.

FOOTNOTES

¹The term "reinforcement" is prevalent in discussions of the areas of both classical conditioning and instrumental learning. Under either paradigm the term refers to a set of conditions which may be introduced to increase the probability of a specific response in similar situations (Kimble, 1961). However, the meaning of the term or, more specifically, what is identified as reinforcement is dependent upon the particular procedure to which discussion refers.

In the case of instrumental procedures, reinforcement refers to a set of events resulting from or following a usually overt act on the part of the S, which tends to increase the probability of the same behavior under similar conditions. For example, the presence of food in the right arm of a "Y-maze" may be assumed to be one aspect of the reinforcement of the learned choice response. If food serves as the reinforcing agent, it is effective only after the particular response has occurred.

On the other hand, discussions of classical conditioning tend to refer to reinforcement in terms of a specific sequence of events usually independent of the prior occurrence of a particular response. For example, reinforcement may be defined as the occurrence of the UCS

within some interval of time following presentation of the CS. With the exception of classical avoidance paradigms, presentation of the UCS is not dependent upon the emission of a particular response. In addition, there is clear evidence that, in the appropriate temporal sequence, repeated presentations of the CS and UCS lead to an increased probability of the emission of a particular behavior called the conditioned response (CR). Because of this, it appears appropriate to refer to reinforcement of the CS as presentation of the UCS. However, the UCS itself is not a reinforcer. What behavior occurs between the CS and UCS and its effect upon the UCS determine to what extent there is reinforcement (Prokasy, 1965). Thus, reinforcement may refer to either of two aspects of classical conditioning; presentation of the CS-UCS contingency and instrumental effects of the UCS upon the CR. This is unfortunate to the extent that confusion arises in interpreting the meaning of "reinforcement". Yet, there appears no alternative term which would eliminate the confusion and express, at the same time, the processes assumed to occur in classical conditioning.

²Runquist, W.N., Brown, Peggy-Anne, Haney, R., and Kinkaide, P. "UCS intensity and partial reinforcement."

Unpublished apprenticeship research, University of Alberta, 1969.

³All groups are identified by assignment to conditions of the experiment. The order of identification is by masking procedure, schedule of reinforcement, and UCS intensity. Thus, group OM-P-50 refers to Ss conditioned under the original masking procedure, receiving a schedule of partial reinforcement during acquisition and a UCS intensity of 50-mm/Hg.

Appendix A

Schedule of 50% partial reinforcement

R denotes a reinforced trial. That is, the UCS was presented 500 msec. following onset of the CS. N denotes a nonreinforced trial upon which the UCS was omitted.

R N N R N R N R R N N N R N R R R N N R N R R N N R N N R R
N R R N N R N N R R N R R N R N R N N R N R N N N R N R R R
N R R N R N R N N R N R N N R N N R R R N N R R N N R N R R

Appendix B

Instructions to Ss

Be sure that you are seated comfortably. Please remain seated as quietly as possible during the experiment. Listen carefully to the following instructions and follow them to the best of your ability. I cannot tell you the purpose of this experiment at this time except that we wish to consider the effects of distraction on performance in a difficult problem solving situation.

On the wall in front of you there are three lights. The light in the centre will be turned on and then one of the outside lights - either the one on the left or the one on the right - will be lighted up. Your task in this experiment is to outguess the experimenter on each trial, or at least as often as you can. As soon as the light in the centre is turned on, you are to guess whether the light on the right or the light on the left will be turned on next. You are to indicate your choice by pressing one of the pushbuttons you hold in your hands. If you think the right light will be lighted press the button in your right hand. If you think it will be the left light press the button in your left hand. When you make your choice, press the button once and please do not

hold it down.

Please tell me what you are to do.

Fine. You will now have four practice trials.

Do you have any questions?

Fine. During the experiment you will also receive some other stimuli consisting of a tone and a puff of air. It is extremely important that you do not control any of your natural reactions to these stimuli. Just remain as relaxed as possible and let your reactions take care of themselves.

The rest of the experiment will have to run without any interruptions. Do not touch anything on your head or communicate with one another. Try to make a choice each time you see the center light come on. Make a guess the first time you see the center light and then try to improve your guesses as you go along.

You may communicate with me at any time by speaking up clearly. Do you have any questions before we start?

Fine. We will begin immediately.

(Response read in answer to questions of the experimental procedure.)

I have told you everything that will happen during the experiment. There are no tricks or catches. We simply want to see how well you can profit from past

experience in a rather difficult problem solving task under conditions of distraction. If you have any specific questions, I will be glad to answer them after the experiment.

B29961